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ABSTRACT

This manual is designed to prepare students for entry-level positions as tree care professionals. Addressed in the individual chapters of the guide are the following topics: the tree service industry; clothing, eqiupment, and tools; tree workers; basic tree anatomy; techniques of pruning; procedures for climbing and working in the tree; aerial lifts; tree identification; identification and treatment of tree problems; and other tree care operations. Appendixes to the manual contain first aid procedures and lists of selected common plants of North America, followed by references and a glossary. Each chapter begins with a set of objectives followed by instructional text. (MN)

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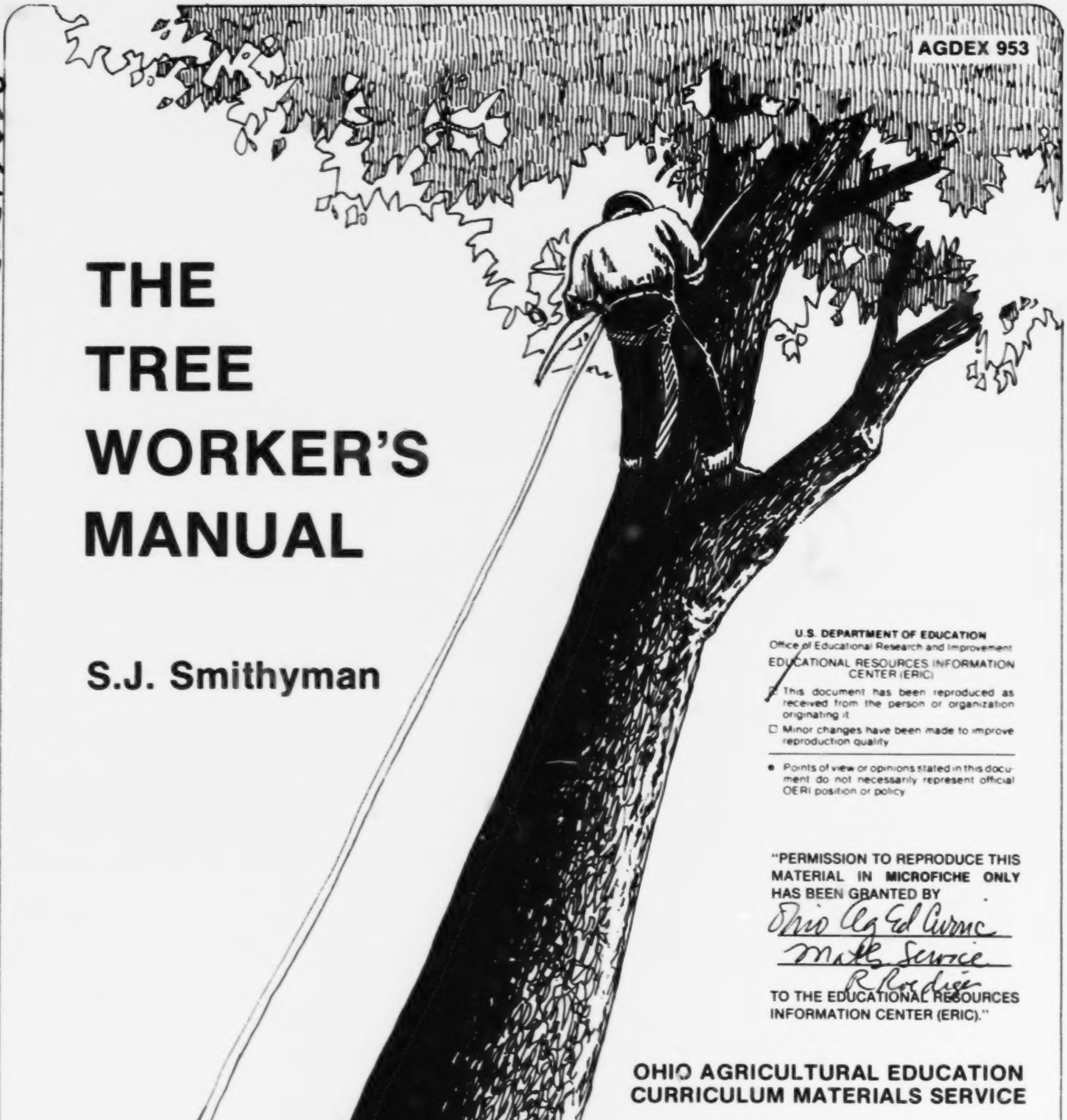

THE TREE WORKER'S MANUAL

S.J. Smithyman

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THE TREE WORKER'S MANUAL

by

S.J. Smithyman

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1985

FOREWORD

The purpose of *The Tree Worker's Manual* is to acquaint the reader with the general operations of the tree care industry. The manual covers a wide variety of subjects that are important to a tree worker. Each chapter begins with a set of objectives that should help the student to gain an understanding of the material. This manual is intended to serve as a training aid for workers at the entry level as tree care professionals.

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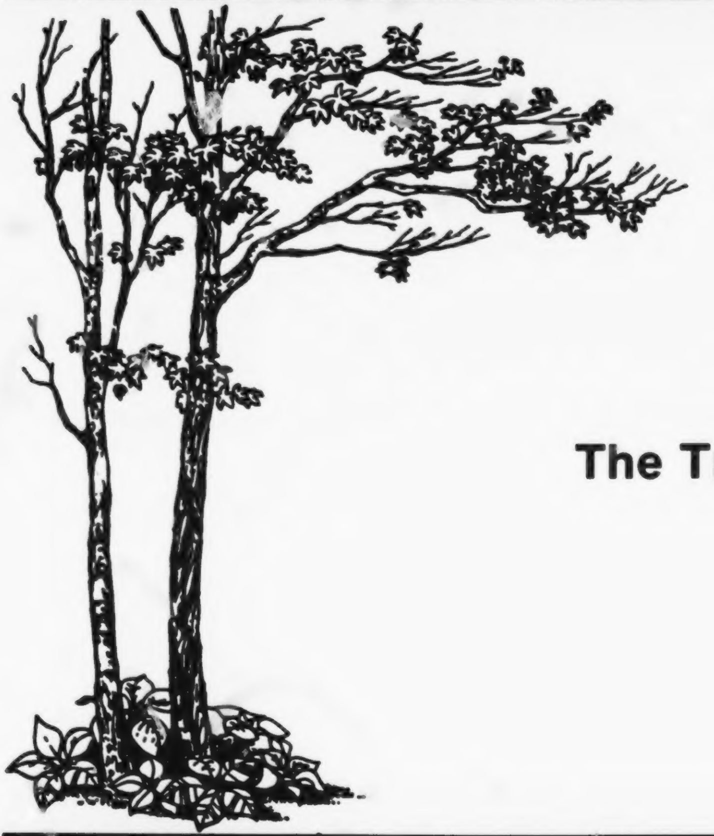


CHAPTER 1

The Tree Service Industry

Objectives

The major goal of Chapter 1 is to provide students with an overview of the tree service industry, and to acquaint the student with the opportunities and requirements for employment.

1. Identify the major divisions within the industry.
2. Learn the various positions within a typical tree crew.
3. Become familiar with the requirements and qualifications for each employment classification.

Introduction

A career in the tree care industry can be both rewarding and fulfilling. The results of a hard day's work are immediately apparent. It is gratifying to see what can be accomplished with a little skill, proper training, some basic knowledge, and lots of sweat.

Tree care is a profession for people who like to work outdoors. It involves working with nature while enduring the elements. Most people would envy the tree worker on a lovely day, working outside in the trees among the birds and squirrels. Unfortunately, not every day is beautiful, and nature does not always cooperate with the tree worker (Figure 1.1).

The tree care professional must be physically fit. Days can be long; endurance is the key to success. Almost every daily task requires strength and stamina. Whether sweltering in the heat or shivering in harsh winter winds, the tree care worker will find it pays to be in shape (Figure 1.2).

Tree care is a profession in which daily objectives or career goals can be attained through hard work and perseverance. Whether working your way up a tree, or working your way up the ladder of success, dedication to a job well done is the most important factor. For the person who would rather push a saw than a pen, rather climb a tree than a staircase, and rather stack wood than paper, tree work can be a most rewarding career (Figure 1.3).

Employment Opportunities

The tree service industry can be divided into two major classifications, private and governmental. The latter usually consists of city- or state-operated tree crews. They work exclusively on city- or state-owned property and trees.

Figure 1.1. Maintaining harmony with nature is not always easy.

Figure 1.2. A climber must be in good shape to "piece-out" a large tree in the middle of winter.

Private tree companies are somewhat more diversified. Work done by these crews may be residential, commercial or utility oriented. Residential work involves tree care for the homeowner and is most often done on a job-by-job basis. Commercial work can range from contracts with large businesses for ongoing tree service to simply trimming a small tree for the corner drugstore. As shown in Figure 1.4, utility work can involve line clearance, right-of-way clearance, and often emergency removal of trees or limbs from power lines. It is done on a contract basis with power or telephone companies and is often the main thrust of larger tree service companies.

Private tree companies may also contract to work for municipalities to trim or remove city trees. This eliminates the need for city crews and may be more cost effective for smaller cities.

As a rule, the well-trained tree worker does not have difficulty in finding employment in any of these divisions within the industry. Most employers are always on the look-out for a

Figure 1.3. Tree work can be a rewarding career for both men and women.

Figure 1.4. Line clearance is a major part of many tree care companies.

responsible worker. As long as people want to coexist with trees, there will be jobs for tree trimmers.

The services provided by tree companies are varied. Utility crews may work daily to clear strips of land for utility lines, poles or roads. Other crews trim city trees away from power lines to avoid interruption of service. These crews play a vital role because of the importance of electrical and telephone service to businesses, hospitals and homes.

Residential tree services provide other services as well. Trees may be trimmed or removed to avoid hazards such as dead or unsafe limbs falling unexpectedly. Also trees are trimmed to increase the life expectancy of the tree, to remove unhealthy or poorly formed branches, or just to increase the aesthetic value of the tree (Figure 1.5).

Tree companies provide other services besides trimming and removal. Some companies spray trees to treat diseases and insect problems. Trees sometimes must be cabled or braced to decrease the chance of splitting during storms. Trees may be wired to prevent lightning damage. Other services include transplanting, fertilization and advice.

Technology is providing the tree care professional with new options. Unhealthy trees can be injected or implanted with fertilizer or chemicals to treat previously difficult-to-treat problems. Growth regulators are being used to limit tree growth below power lines. Work is being done to promote the use of wood chips as an energy source. Research in these areas is important to the tree service industry.

Figure 1.5. Thinning can make trees safer and more attractive.

Job Descriptions

It is important that any potential employee be aware of the requirements of a job before being hired for that position. Many companies have written job descriptions which list the qualifications, requirements, and sometimes the salary or wages for that job. Some sample job descriptions are included in this manual.

BUCKEYE TREE CARE, INC.

JOB DESCRIPTION

SUPERVISOR

The supervisor is responsible for a crew. Work assignments must be picked up each morning; the supervisor has the responsibility to complete each job to the satisfaction of the client. The supervisor is the primary customer contact and must provide friendly and efficient service to the public.

Requirements

- supervise work of each crew member
- climb and work in trees when necessary and appropriate
- coordinate all tree and ground operations
- operate chain saws, pole pruners and chipper
- drive and care for chipper truck
- maintain all equipment on truck
- serve as primary customer contact for crew
- be responsible for safety of crew

Qualifications

- high school diploma
- full training as climber and in all phases of tree care
- knowledge of trees and shrubs
- certification in CPR and first aid
- driver's license
- minimum 5 years' experience

Starting Wage: $9.00 per hour (as of 1985)

BUCKEYE TREE CARE, INC.

JOB DESCRIPTION

CLIMBER

The climber does most of the actual climbing, trimming and "rigging" of trees. The climber works primarily out of a rope and saddle and at times from an aerial bucket truck. Climbers must be physically fit and competent with all their equipment.

Requirements

- climb, trim and remove trees
- be competent and safe with chain saw
- take primary responsibility for rigging and roping
- be trained in and aware of all safety procedures
- have a basic knowledge of pruning principles
- be responsible to and report to supervisor

Qualifications

- minimum 2 years' climbing experience
- training in tree care operations
- training in aerial rescue and other safety procedures
- training in first aid
- minimum 18 years of age

Starting Wage: $5.75 per hour (as of 1985)

BUCKEYE TREE CARE, INC.

JOB DESCRIPTION

GROUND WORKER

The primary responsibility of the ground worker is to assist the climber. This includes sending up tools, equipment and extra ropes. The ground worker also operates saws, pruners and the chipper. The ground worker often has to coordinate several ropes at the same time.

Requirements

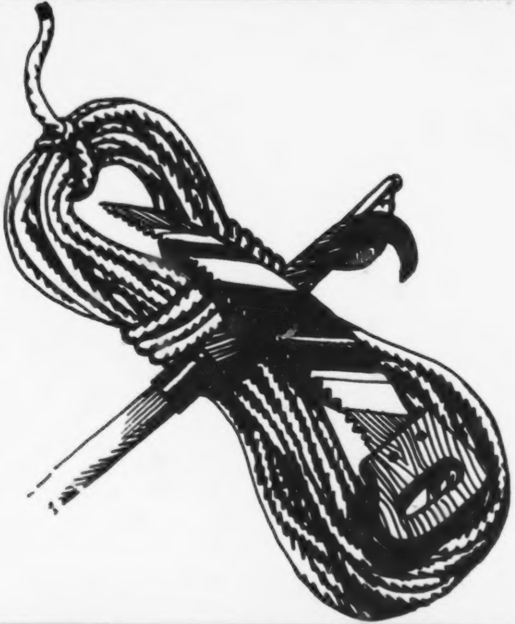
- assist climbers at all times
- drag, chip and cut brush and fallen limbs
- cut and stack firewood
- assist in roping limbs
- rake, sweep and clean up work area as required
- assist in maintenance of equipment
- report directly to supervisor
- assist in other tree care operations

Qualifications

- proper training in aerial rescue and other safety procedures
- training in ropes and knots
- training in equipment operation and maintenance
- minimum 16 years of age

Starting Wage: $3.95 per hour (as of 1985)

Some larger tree companies are unionized. Unionization brought standard wage scales, and "levels" were created within the various job classifications. For example, climbers may be rated from **A** to **E**, with **A** being the top climber. Ground workers may be rated **A** or **B**. Normally a worker starts at the lowest level and works up through the ranks.



CHAPTER 2

Clothing, Equipment and Tools

Objectives

The intent of Chapter 2 is to describe and illustrate the equipment that the tree trimmer uses.

1. Become familiar with arborists' equipment and clothing.
2. Know what equipment is required for safety.
3. Learn the various tools and machines that tree professionals use.
4. Become familiar with the different types of rope that are available.

Clothing and Protective Gear

The most important factor in choosing appropriate clothing for outdoor work is common sense. Pants and shirts should be made of durable material (Figure 2.1). Loose-fitting clothing should be avoided, as it may catch in machinery and become a safety hazard. Clothes that are too tight can become very uncomfortable. Jewelry should never be worn when working with equipment outdoors.

Always remember to dress for the weather. In winter it is better to wear several thin layers than one bulky layer. This allows more freedom of movement, and layers can be removed as the temperature rises. In summer thin but strong fabrics are usually preferred.

Figure 2.1. A climber's pants should be strong enough to resist tears without restricting movement.

Head protection (hard hats) must be worn by all tree workers. Figure 2.2 shows several of the hard hats that are available. Safety hats must comply with federal impact and penetration requirements. Protective head gear must conform to ANSI 289.1-1981 Class B helmets when the worker is in proximity to an electrical conductor. Liners are available for winter wear.

When working with brush chippers, stump removers or power saws, the worker should wear eye protection. Safety glasses or goggles like those in Figure 2.3 will protect eyes from flying debris. Although goggles tend to be uncomfortable, failure to wear them can be very costly.

It has been demonstrated that continued exposure to the noise of power saws and brush chippers can cause permanent hearing loss. Ear protection is required when using such equipment. Yet workers must be able to hear surrounding sounds that may include warning calls or cries for assistance. The use of ear plugs or earmuff-type protection (Figure 2.4) that cuts down noise levels, yet still allows the worker to hear, is recommended.

Gloves are optional except, of course, in winter. Heavy leather, gauntlet-type gloves (Figure 2.5) may be worn when chipping brush. Smaller, more closely fitting gloves are often worn for climbing.

When chain saws are used on the ground, leg protectors or "chaps" can be worn. Leg guards such as the ones shown in Figure 2.6 are specially constructed to prevent chain saw cuts on the legs. These guards can be bulky and are not appropriate in the tree.

Boots should be worn by all tree workers. There are many styles and types. Steel-toed boots (Figure 2.7) are good for extra protection. But some climbers avoid steel-toed boots, as they sometimes get stuck in crotches. Some climbers prefer high-laced boots (Figure 2.8) because of the extra leg protection they provide. Shorter boots are also available (Figure 2.9). If climbing spurs are to be used frequently, a climber may choose boots with a deep square heel (Figure 2.7).

Climbing Saddles and Ropes

A climbing saddle is very important to the climber. There are many styles and types of safety

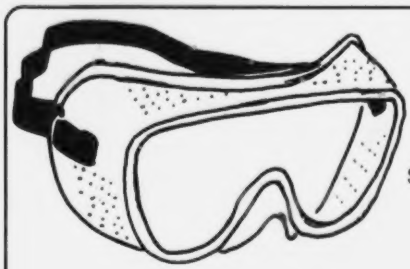


Figure 2.3. Safety goggles

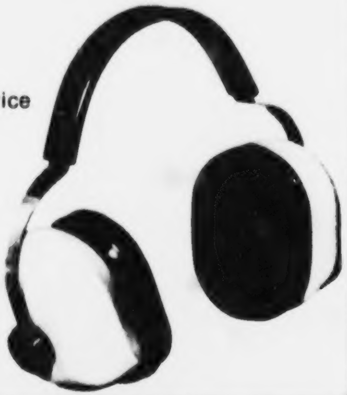


Figure 2.4. Ear protection device

Figure 2.2. A variety of safety caps and hats

Figure 2.5. Leather gloves protect the hands when chipping brush.

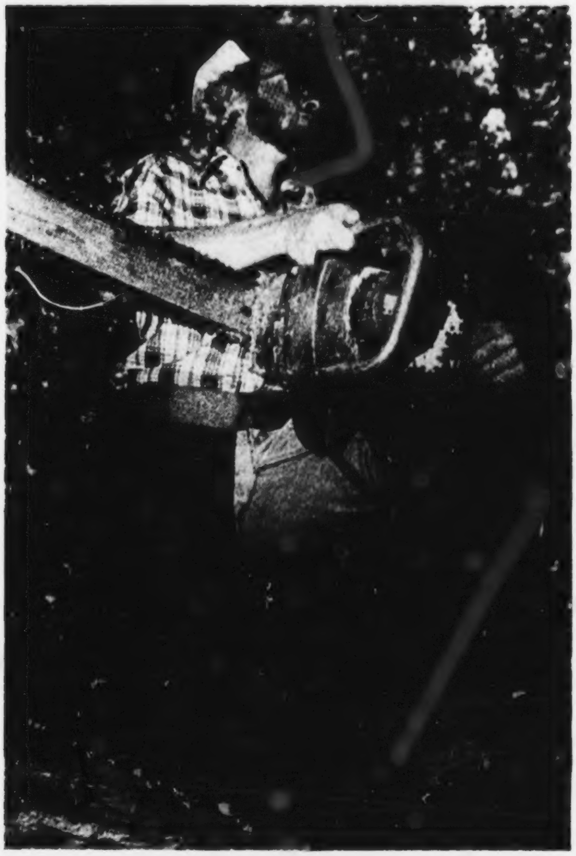


Figure 2.6. Special leg protection can reduce the chances of serious injury.

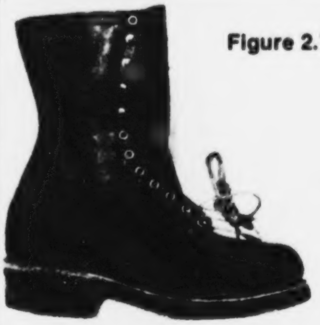


Figure 2.7. Steel-toed boots

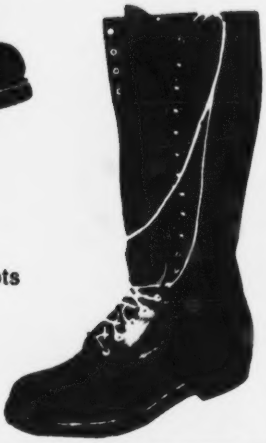


Figure 2.8. 16-inch high-laced boots

saddles (Figure 2.10). A climber may use one type of saddle for many years and will swear by that particular type. Choosing a style of climbing saddle is mostly a matter of personal preference.

The saddle may be constructed of various materials. Many older saddles were made of leather only. They tended to stiffen after exposure to rain, cracking and wearing with age. Newer saddles are often made from 3-inch cotton web belting backed by nylon or other synthetic materials. These double-thick, newer saddles tend to be lighter in weight and are affected less by moisture.

All climbing saddles have an adjustable waist belt. Some seat-type saddles have a second wide strap that creates a seat when the climber is

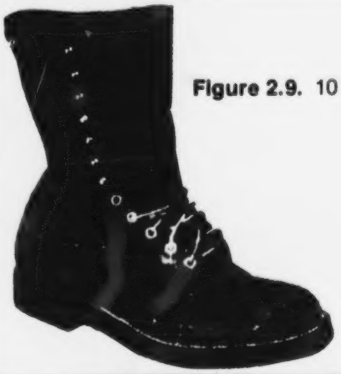


Figure 2.9. 10½-inch laced boots

Here's the saddle you asked for

Figure 2.10. Be familiar with your equipment.

suspended on the climbing rope (Figure 2.11). Other saddles have large, adjustable leg loops which serve the same purpose. Some climbing saddles have leather leg straps (attached to the seat strap) that buckle in front. The leg straps help to keep the saddle in place when one is climbing. The climber in Figure 2.12 is using a saddle with adjustable leg straps.

The safety saddle serves a second purpose: it provides a means of carrying equipment. A good saddle should have four "D" rings for clipping on the safety line and climbing rope. Additional rings and clips may be used to attach the handsaw and scabbard, a chain saw, or a tool bag. In Figure 2.13 the climber has his safety line attached to a side "D" ring. Several other rings and snaps can be seen.

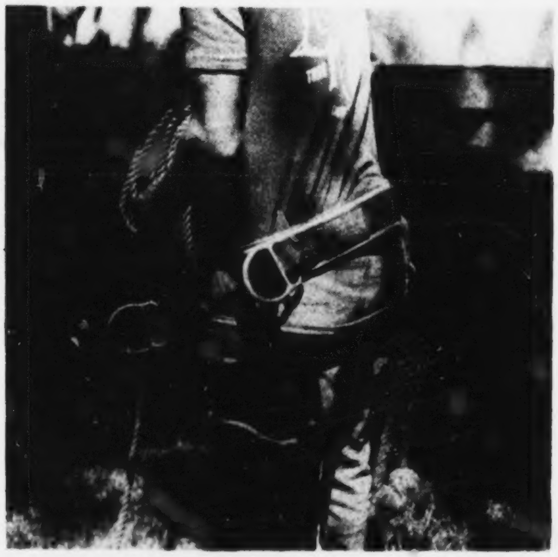


Figure 2.11. The safety saddle should fit snugly but comfortably.

Figure 2.12. Leg straps should be tight without restricting movement.

Perhaps the most important equipment that tree workers use is rope. Ropes are used to lower large limbs and to pull branches or entire trees in a certain direction. The climber's rope is used not only to insure safety, but also to aid the climber in maneuvering within the tree. The climbing line can help the climber maintain balance when walking out on a limb to make a cut (Figures 2.14, 2.15).

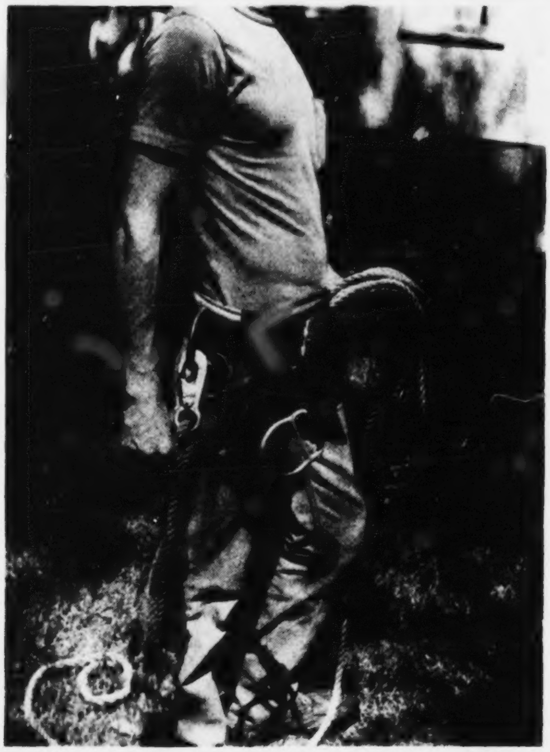


Figure 2.13. A climber must be able to work with many tools in the tree. These tools are often clipped on the safety saddle.

Figure 2.14. The climbing rope helps the tree trimmer maintain balance.

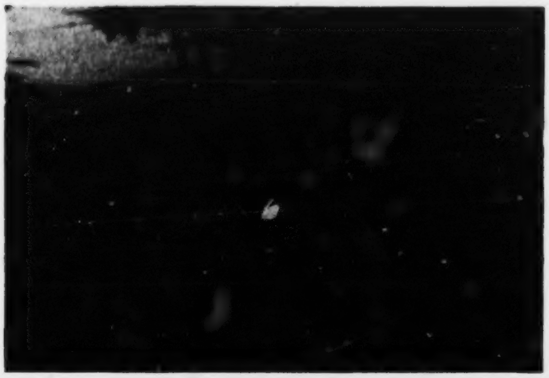


Figure 2.15. This climber relies on her rope to remain steady and safe while making the cut.

Ropes that are generally used in the tree business range from ⅜ inch to 1 inch in diameter. Small hand lines may be used for small branches or to tie off small trees. Large "bull ropes," often ¾ or 1 inch in diameter, are used to lower very large limbs. The climbing line is not less than ½ inch in diameter and typically 120 feet long. Hand lines and bull ropes are frequently longer. Climbing lines should never be used for anything else, since the climber's life depends on the integrity of the rope.

Ropes can be made of various materials. Manila ropes are made from organic material; this can begin to rot with age and exposure to moisture. Even after treatment of the fibers to reduce rotting, manila ropes must frequently be checked to make sure they are safe to use. Manila ropes are not used as much as they once were.

Most ropes used in the trade today are made of synthetic fiber. One commonly used material is nylon. Nylon is much stronger and longer lasting than manila, but it has its faults. Since nylon rope tends to be elastic, one must allow for stretching. Also, nylon ropes may glaze from the heat of being run through a crotch when lowering a heavy limb. A better synthetic material for ropes is polyester. Two of the more commonly used materials are Dacron® and Esterlon®. These ropes are stronger than manila, and there is no worry about rotting or mildew. Figure 2.16 shows a variety of ropes constructed of manila and synthetic fibers. A comparison of main characteristics of the different kinds of rope is given in Table 2.1.

Many climbers have begun using braided ropes rather than twisted lines. Braided ropes are more expensive, but they practically eliminate the unwanted twisting and kinking of the line (Figure 2.17). Braided ropes also provide better knot control.

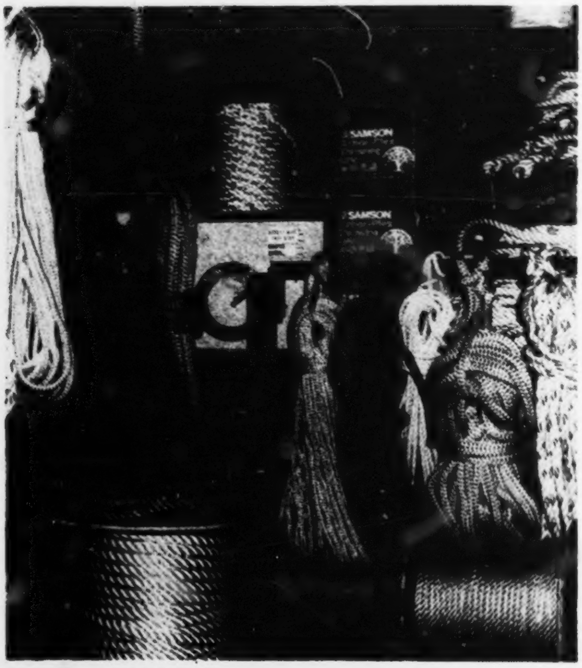


Figure 2.16. A tree worker uses many types and sizes of ropes.

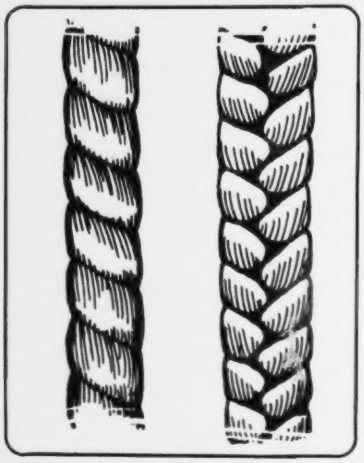


Figure 2.17. Contrasting twisted and braided rope

Selection of the right rope for the job is important. Always choose a rope that is strong enough for the load. Frequently the tree worker must estimate the load a given limb will put on a rope. Experience helps in calculating such things, but accidents rarely occur from using a rope that is *too big*.

Proper care of a rope will help prolong its service life. Ropes should be stored in a dry place away from saws, oil and gasoline. Care should be taken not to cut ropes with chain saws. Flawed or fraying ropes should be cut back to where they are safe. Ropes should be properly tied when not in use. Figure 2.18 shows how to tie a rope for storage.

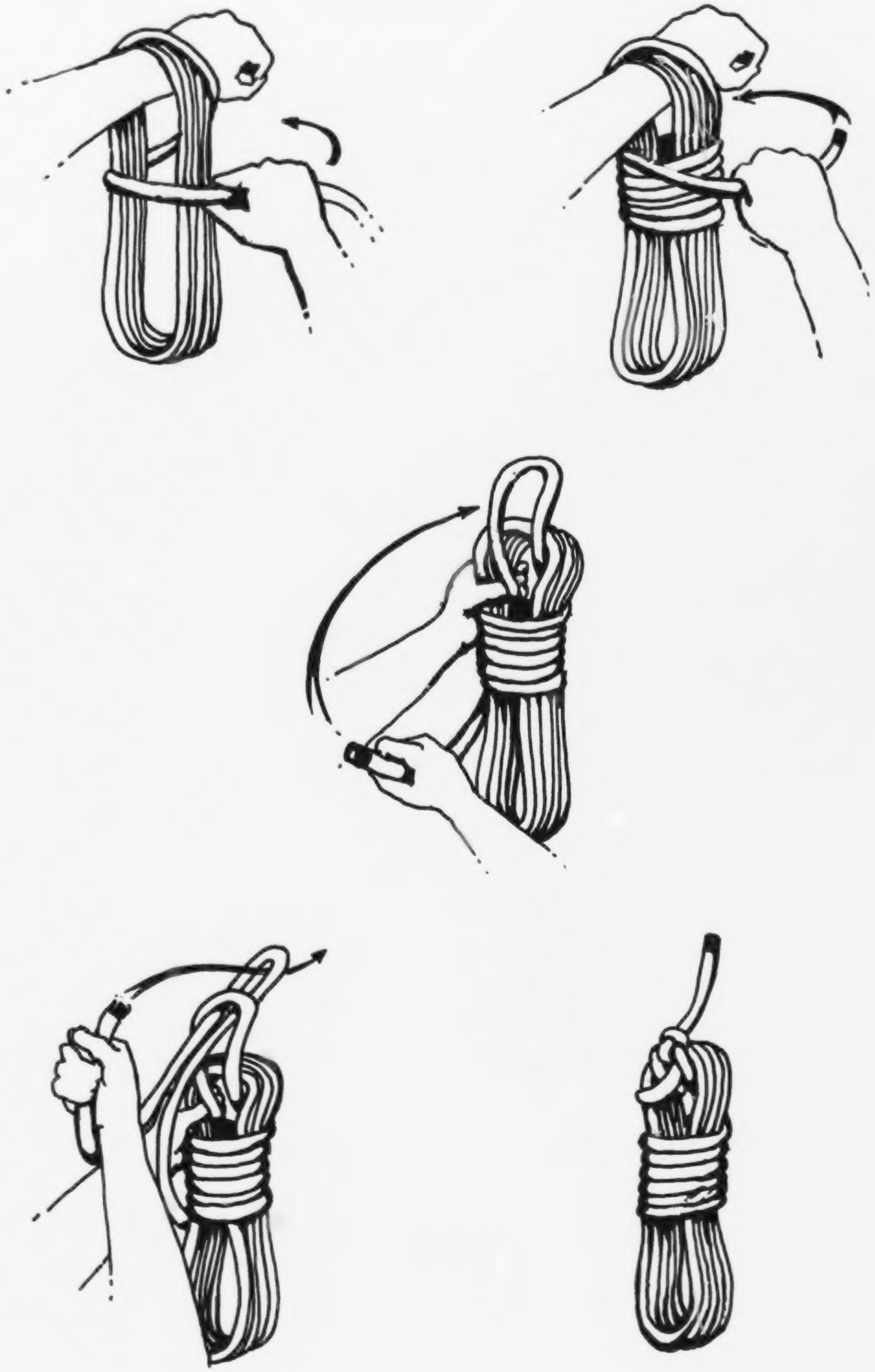


Figure 2.18. Wrapping a rope for storage

Other Tools and Equipment

A climber in the tree uses several snaps or clips to attach tools to the climbing saddle. Some snaps have been designed to pivot, while others remain stationary. Pivoting snaps are an advantage for carrying a chain saw, since they allow the climber to rotate the saw to a more comfortable position. Some frequently used snaps are shown in Figure 2.19.

Another helpful tool for the climber is climbing spikes (Figure 2 20). These allow the climber to ascend a branchless trunk without much effort. However, use of spikes on a live tree that is being preserved is **not** recommended. Reputable companies allow climbers to use spikes only on

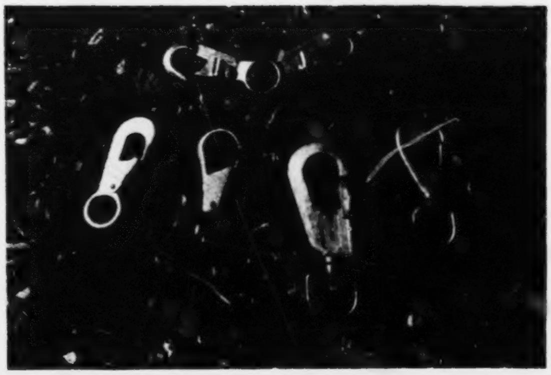


Figure 2.19. The double snap may be clipped between two "D" rings and the climbing rope passed through the center.

Table 2.1. Comparison of characteristics of **one inch rope** made from manila, nylon, Dacron polyester, and Esterlon polyester.

			Polyester	
Description	**Manila**	**Nylon**	**Dacron**	**Esterlon**
Strength Characteristics				
Tensile Strength Dry	9,000 lbs.	25,000 lbs.	22,000 lbs.	20,000 lbs.
Working Strength	1,800 lbs.	2,890 lbs.	2,450 lbs.	2,220 lbs.
Repeat Loading	Poor	Good	Excellent	Good
Elasticity-Stretch				
Permanent Elongation at Working Loads	4.8%	8.0%	6.2%	6.0%
Temporary Stretch under Load	5.0%	16.0%	5.9%	6.5%
Water Absorbed into Fiber	Up to 100% of weight of rope	Up to 9%	Less than 1%	Less than 1%
Resistance to Rot, Mildew and Marine Organisms	Poor	100% Resistant	100% Resistant	100% Resistant
Deterioration				
Due to Aging	About 1% per year	Zero	Zero	Zero
Due to Sunlight Exposure	Some Slight	Some Slight	Almost None	Almost None
Resistance to Chemicals				
To Acids	Very Poor	Fair	Very Good to Excellent	Very Good to Excellent
To Alkalis	Very Poor	Excellent	Very Good	Very Good
To Solvents	Good	Good	Very Good to Excellent	Very Good to Excellent
Wear				
Resistance to Surface Abrasion	Good	Very Good	Excellent	Excellent
Resistance to Internal Flexing Wear	Good	Excellent	Very Good to Excellent	Very Good to Excellent
Resistance to Cutting	Good	Excellent	Very Good to Excellent	Very Good to Excellent

This table was compiled from "Table of Natural and Synthetic Fiber Characteristics" developed by Wall Rope Works, Beverly, New Jersey.
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trees that are being removed. Besides creating unsightly scars in the trunk, climbing spikes usually cause wounds in the tree which later may provide an entry path for insects and diseases.

One of the primary tree-trimming tools is the handsaw. Tree saws are specially designed with the teeth pointed back to cut on the pull stroke. Figures 2.21 and 2.22 show a variety of handsaws. An important accessory of the handsaw is the scabbard, a sheath in which the handsaw is carried and stored (Figure 2.23). Scabbards usually have a clip and a ring for attaching to the saddle. The scabbard also helps protect the climber's pants from handsaw cuts.

Pole pruners and pole saws are used to make difficult-to-reach cuts. The pole saw is a pruning saw attached to a long pole (Figure 2.24). The pole

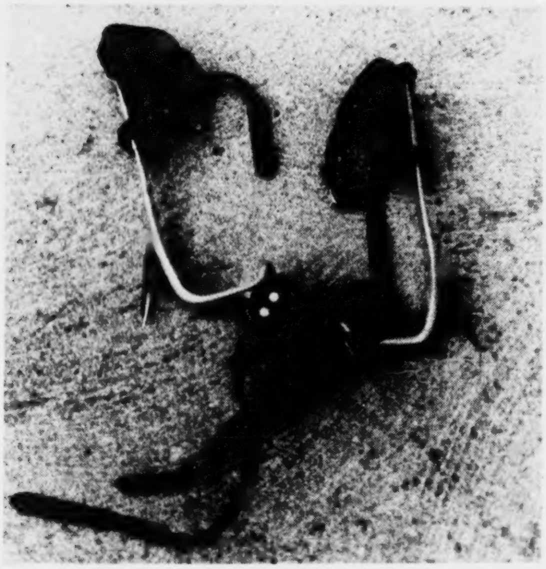


Figure 2.20. Climbing spikes should be used only on trees to be removed.

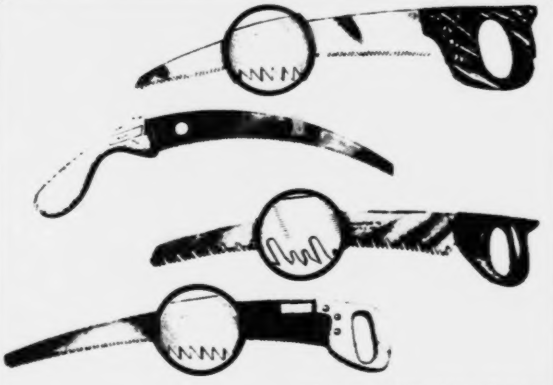


Figure 2.21. Handsaws

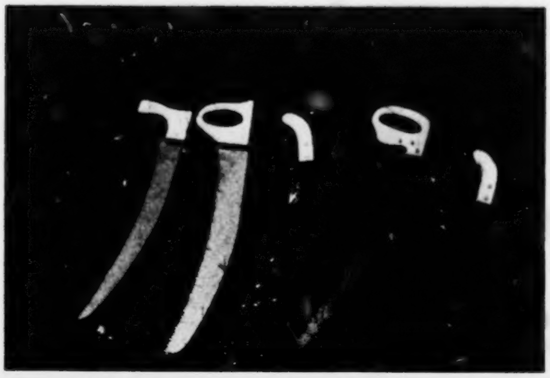


Figure 2.22. Handsaws and scabbards

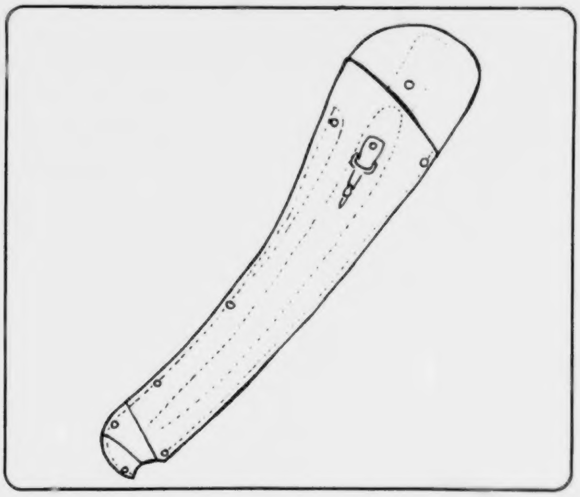


Figure 2.23. Scabbards must be sturdy to hold up in bad weather.

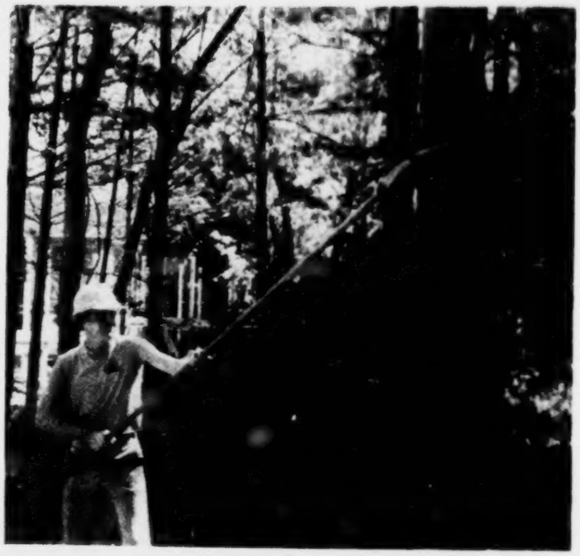


Figure 2.24. This worker demonstrates the utility of a pole saw.

pruner or "pole clip" (Figure 2.25) can be used to prune twigs up to 1 or 2 inches in diameter, depending on the "bite" of the pruner. Sometimes pole pruners and pole saws are combined into a single tool. Figure 2.26 shows a variety of these tools. Frequently pole pruners are made so that extensions can be added. Utility crews working from bucket trucks often have the use of hydraulic pruners (Figure 2.27). Such a tool reduces the effort needed to make the cuts and usually significantly decreases the time involved.

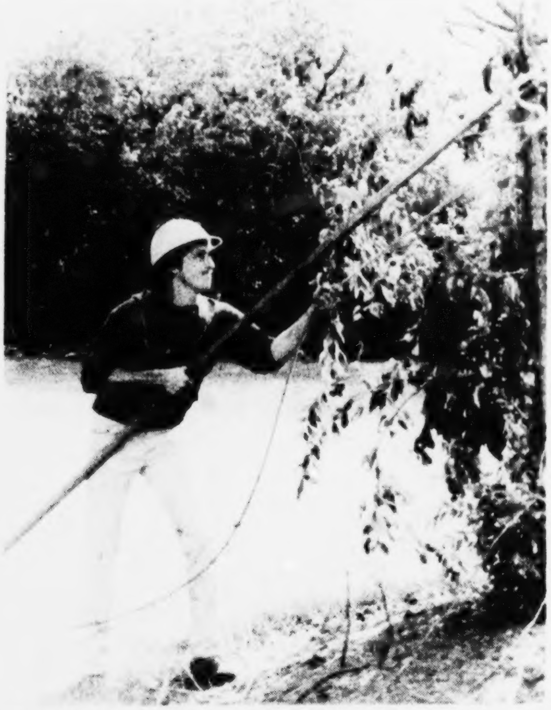


Figure 2.25. Making a cut with a pole pruner

Figure 2.27. Hydraulic pruners are a great advantage for the utility arborist.

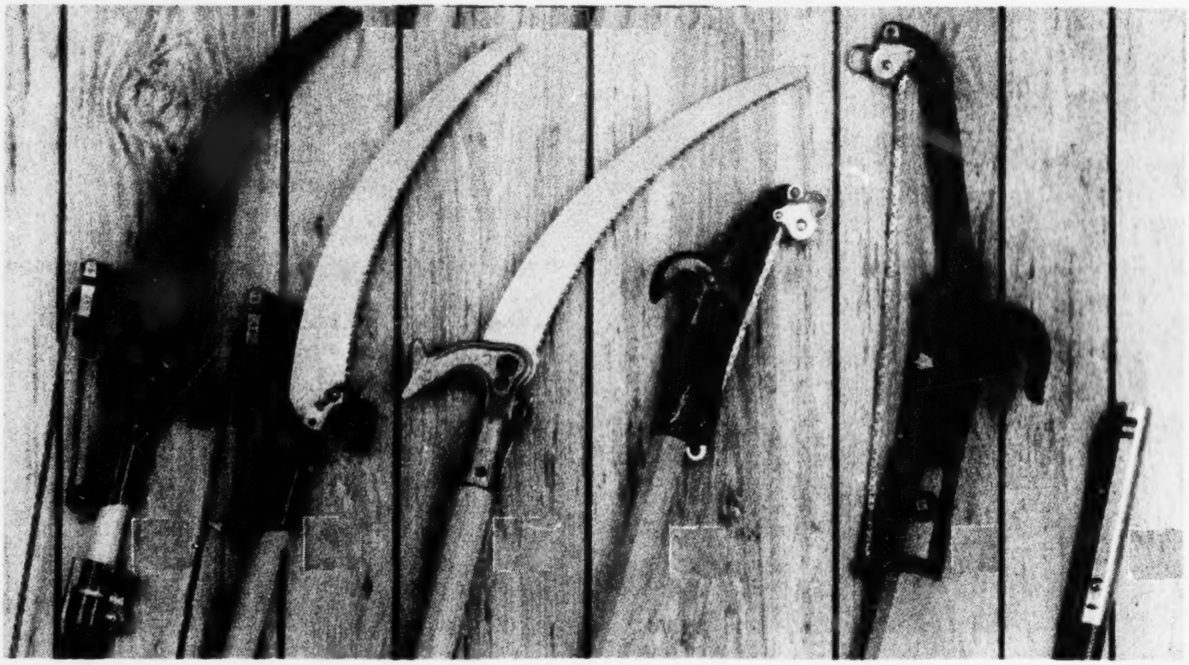


Figure 2.26. Pole pruners and pole saws are for difficult-to-reach limbs.

Other pruning tools include hand pruners and lopping shears, or "loppers" (Figure 2.28). These tools are more frequently used on the ground. Most hand pruners cut up to ½-inch twigs. Loppers may cut 1½-inch branches.

Whenever chain saws are used, fuel will most likely be carried on the truck. It is important that the gasoline be stored only in safe and approved containers (Figure 2.29). Gas cans should be carried in such a way that they will not spill or be exposed to possible sparks.

A number of miscellaneous pieces of equipment important to tree workers should also be carried (Figure 2.30). A good tool kit for minor repairs should be kept handy. Clean-up tools such as rakes, brooms and a scoop shovel are needed. Many crews carry a water container, especially during the hot summer months. Certainly a first-aid kit should be carried at all times. Minor cuts are a routine occurrence in the tree business. Finally, the annoyance and irritation of insect and other bites can be warded off with a good supply of insect repellents, as shown in Figure 2.31.

Figure 2.28. "Loppers" are good for relatively small cuts.

Figure 2.29. Gasoline must be stored only in approved containers, clearly labeled.

Chain Saws

The chain saw is probably the most often used and most dangerous piece of equipment that a tree worker deals with. On the ground chain saws are used for cutting down trees and sawing them into firewood-sized logs and branches for chipping or loading. In the tree chain saws are used for large cuts. Using a chain saw to trim a tree can greatly reduce the time and effort involved, but care must be taken to insure the safety of the climber and the ground workers. Careless use of a chain saw in a tree can cause considerable damage to the tree. Sloppy cuts and nicks in desirable branches are a common sign of haphazard chain saw use.

Chain saws are made by many manufacturers and are available in a variety of sizes (Figure 2.32). It is important to choose a saw that is appropriate for the job. If the saw is to be used in a tree, it should

Figure 2.30. A good supply of water can be important.

TICKS OFF
INSECT REPELLENT SPRAY
OFF!
OFF

Figure 2.31. Insect repellents

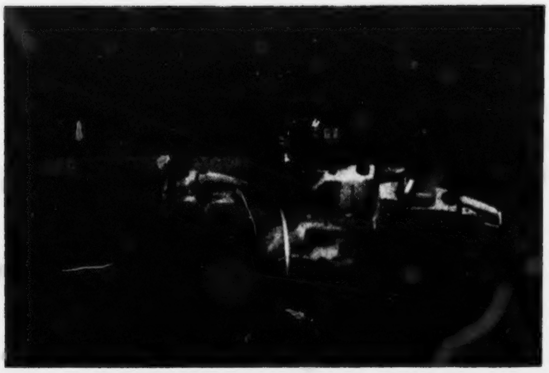


Figure 2.32. A tree service worker uses a variety of chain saws.

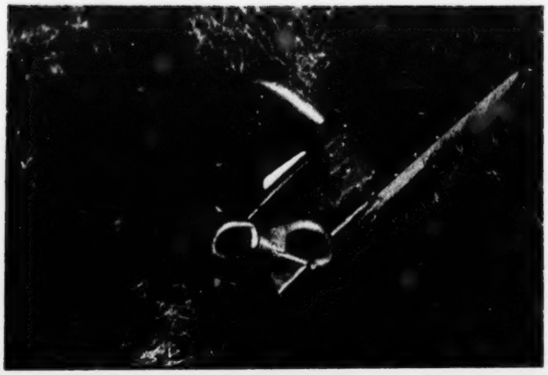


Figure 2.33. A chain saw equipped for use in the tree.

meet the following requirements. It must be lightweight and well-balanced to reduce worker fatigue when being toted and used for hours. It should be powerful enough to handle fairly large cuts without bogging down. For easier control the chain saw should have the rear handle above the engine. Saws with the trigger handle behind the engine are not appropriate for use in trees because they are more difficult to use when reaching out on a limb. Figure 2.33 illustrates a chain saw used by climbers in trees. Note that such tree saws are rigged with a snap or other means of attaching the saw to the climber's saddle.

Frequently, larger, more powerful saws are used on the ground. The engine size of these chain saws ranges from about 20cc to 137cc. Bar length usually ranges from 12 to 42 inches. The bar must be long enough to enable the worker to cut through the tree. A 30-inch log can be cut with a 16-inch bar, but a longer bar might be more useful for felling a 30-inch standing tree. Most larger saws have bumper spikes (Figure 2.34) which grip the log when the cutting action of the chain saw draws the saw into the cut.

Chain saws require proper maintenance to be effective. A saw that is poorly maintained will be inefficient and will pose a greater risk to the user. Chain saws require a fuel mixture of oil and gasoline. A 2-cycle engine oil is added to the gas to lubricate the piston, cylinder and bearings. It is very important that the correct mixture ratio be used. If the mixture contains too little oil, the piston may freeze up within the cylinder. Too much oil in the mixture can cause a reduction in power. Care should be taken to keep dirt and sawdust out of the fuel tank. It is recommended that the bar lubricant tank always be filled when the fuel tank is filled, since a properly running saw will empty both in about the same time.

The air filter should be kept clean and free of dust (Figure 2.35). A dirty filter may make the saw difficult to start. If the air filter gets too dirty, the saw will run as if the choke were left open. The air filter can be cleaned with soapy water and rinsed with tap water.

Another cause of difficulty in starting the saw is a worn-out spark plug. This occasionally has to be

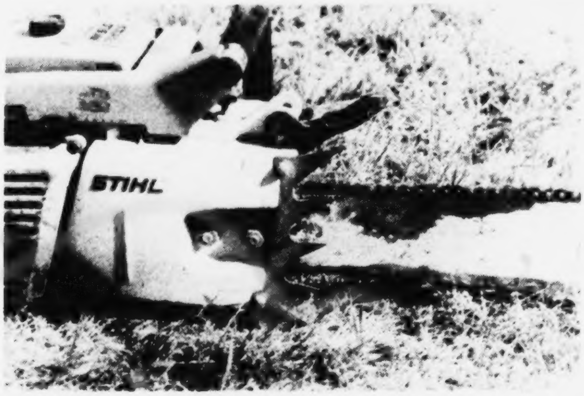


Figure 2.34. This chain saw has bumper spikes and a hand guard to help protect the user.

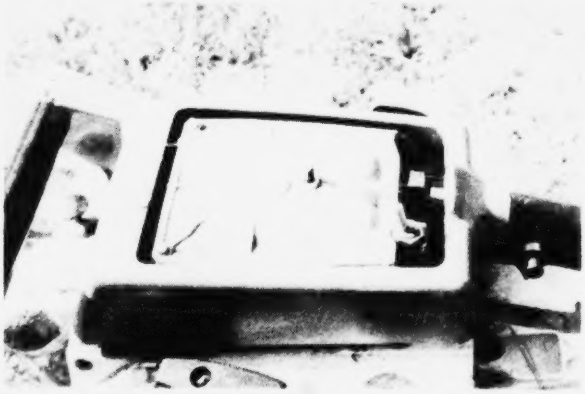


Figure 2.35. The air filter should be kept clean.

replaced. A worn-out spark plug may also cause the engine to "cut out" after it has been started.

The guidebar and sprocket may require some maintenance also. The guidebar should be turned occasionally, since the guide rails wear down faster on the bottom side where most of the cutting is done. The sprocket usually needs to be replaced after two to four chains. A new chain should never be installed over a badly worn sprocket. Guidebars and sprockets will last longer if a good bar oil is always used. Bar oil must have a low freezing point and a high flash point so that heat will not cause ignition while cutting. A high tack, low sling oil will help maximize adherence to the bar and chain.

Before running the chain saw, check to see that the chain is tensioned. To tension the chain, loosen the bar-mount nuts and hold up the bar. Tighten the chain-adjusting screw until the chain is taut. The chain should move freely and snap back when pulled away from the bar. Re-tighten the bar-mount nuts while holding up the bar. A loose chain can cause uneven wear of the chain runners and guide rails of the bar.

If a chain saw has to be forced to cut, the chain is probably dull. Chains are dulled by hitting dirt, metal or stone, and even by normal cutting. The hard wood near the base of the tree can easily dull a chain saw. Very fine sawdust is another indication of a dull chain.

Chains must be filed frequently to sharpen. Remove as little material as possible with each filing. Always use the correct size file for the chain and consult the owner's manual for the correct filing angles (Figure 2.36). It is important to file both sides of the chain evenly, otherwise the saw will cut at an angle. After the chain has been sharpened several times, the depth gauges will have to be filed down with a flat tile. It is a good idea to wear gloves when sharpening a chain saw.

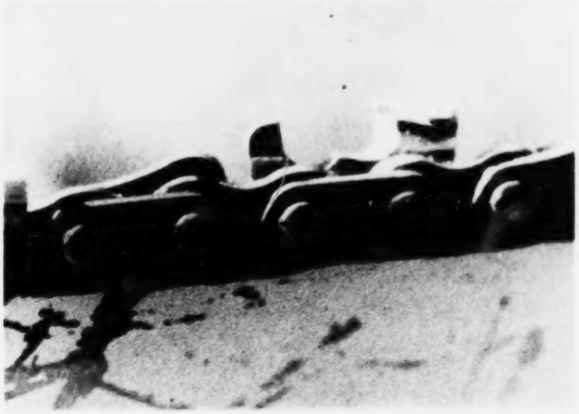


Figure 2.36. The chain must be filed frequently and correctly.

In addition to these maintenance factors, some companies do routine maintenance checks on their chain saws (Figure 2.37). If possible, all the saws should be cleaned at the end of each day. Also, all bolts should be tightened regularly.

Safety is the most important consideration when using a chain saw. Today chains and bars have been designed to minimize kickback, the most common cause of accidents. Other safety recommendations that can help reduce the risk factors involved in operating a chain saw are:

- Never refuel a saw while it is running (Figure 2.38); always wipe up any spilled fuel.
- Never smoke while refueling.
- Always operate a saw with two hands.
- Never cut above shoulder level.

Figure 2.37. Doing routine maintenance on a chain saw.

Figure 2.38. Avoid spilling gas while refueling chain saws.

- Avoid letting the tip of the guidebar contact the log, or kickback may result.
- Wear protective clothing and eye protection whenever practical.

Trucks, Chippers and Stump Grinders

A tree company may own a variety of trucks including pick-ups, spray trucks, chipper trucks and bucket trucks. One of the trucks most commonly used by a tree crew is the chipper truck. There are several different body types in use. Most chipper trucks have a hydraulic lift bed for dumping wood chips (Figure 2.39). Most are also equipped with storage areas for tools, pole pruners, ladders and ropes (Figures 2.40, 2.41). Chipper trucks also have a hitch to fit the chipper as shown in Figure 2.42. Some trucks carry wheel blocks (Figure 2.43) which are especially handy when the truck is parked on an incline while chipping brush. A fully equipped truck and chipper outfit is pictured in Figure 2.44.

Figure 2.39. The rear bed of the truck is raised to dump wood chips.

DAVEY TREE
SINCE 1909

Figure 2.40. A truck with storage areas for all equipment carried

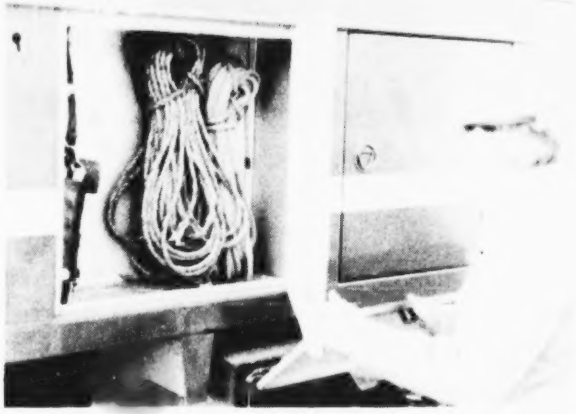


Figure 2.41. Ropes neatly hung in a storage area away from chain saws

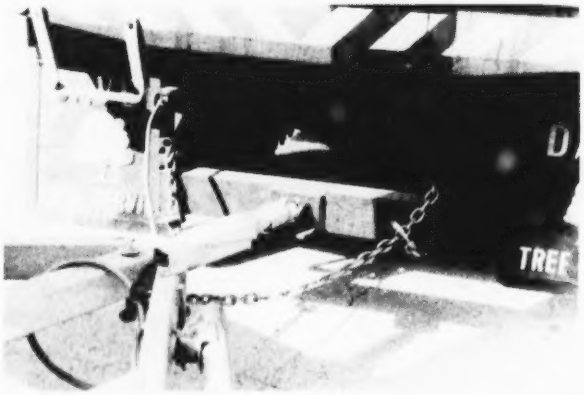


Figure 2.42. The hitch includes safety chains and electrical hook-up between the truck and chipper.

Figure 2.43. Metal wedges used to block the wheels of the truck

Figure 2.44. Truck and chipper

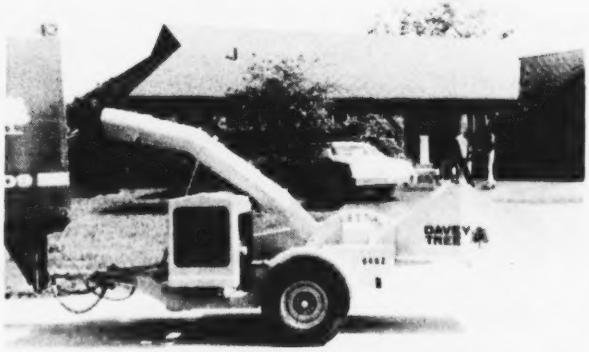


Figure 2.45. Brush chipper. Branches are fed into the rear and wood chips are "shot" into the truck

The **brush chipper** (Figure 2.45) is used to grind branches into wood chips. Chippers come in various sizes. Some can process logs up to 8 inches in diameter. Chippers can be dangerous, so proper operation procedures must be followed. Before starting the engine, be sure there are no foreign objects in the feed chute near the cutting blades (Figures 2.46, 2.47). When the engine has been started, let it idle before cranking it up to chipping speed. Engage the clutch at about one-third throttle, then open the throttle fully after the chipper is warmed up.

The following safety recommendations for chipper operation should be observed.

- Wear gloves, safety glasses, ear protection, and proper clothing. Avoid loose-fitting clothes and do not wear jewelry, as both can easily be caught in the chipper.
- Feed brush from the side of the feed chute to avoid being hit by pieces of wood that may be ejected to the rear.
- Never put anything but branches or brush in the chipper.
- Never reach into the chipper with your hands or try to shove brush in with tools or your feet.
- Always be sure the chipper is safely anchored to the truck.
- Never make any adjustments or repairs while the chipper is in operation (Figure 2.48).

If the chipper is to operate safely and efficiently, the blades must be sharpened occasionally. Figure 2.49 shows a worker removing the cutting knives from the cylinder to replace them with sharp ones. When the bolts are being tightened, make certain that they are properly "torqued down." The rapid rotation of the cylinder could easily cause a knife that is loose to be dangerously ejected. Finally, make certain that no metal or stones are fed into the chipper, as these will dull the blades.

Figure 2.46. Checking the feed chute before starting the chipper

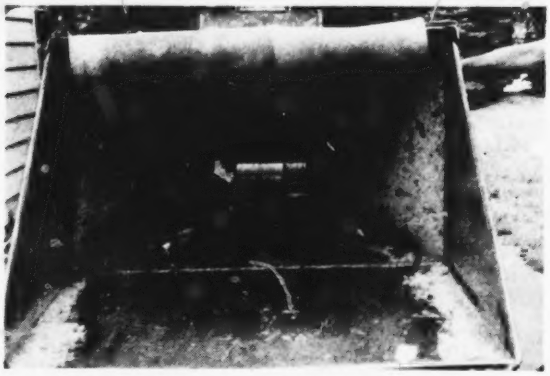


Figure 2.47. All foreign objects are out of the feed chute.

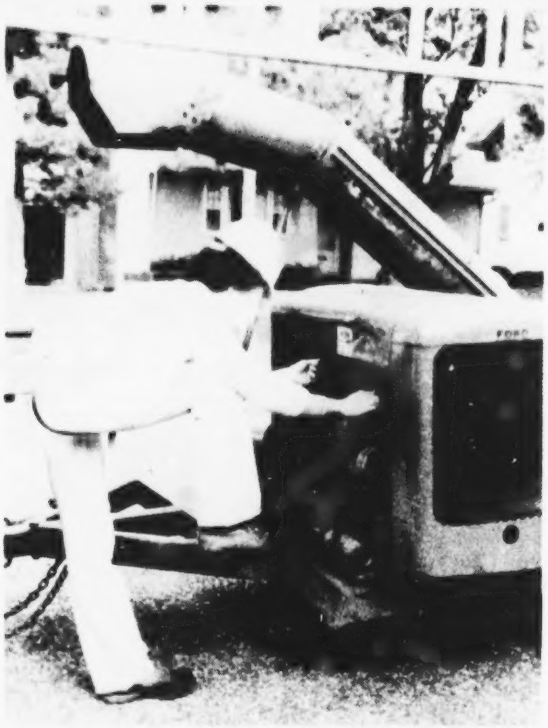


Figure 2.48. Never make adjustments while the chipper is running.

Figure 2.49. Cutting knives of the chipper must be removed and replaced when they get dull.

A **stump grinder** is used to dig out the below-ground portion of a tree stump. The depth that the machine will go depends on the size and make, and varies from 8 inches to 30 inches. Figures 2.50 and 2.51 illustrate two different sizes and types of stump grinders. Operators of these machines always wear protective goggles, since stones and wood chips can fly out from the stump. As with other equipment, maintenance is important. The teeth or grinders must be sharpened or replaced routinely. Belts should also be checked on a regular basis.

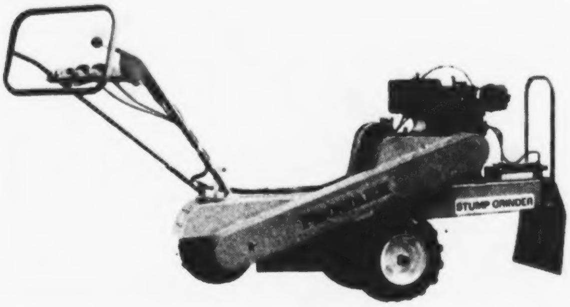


Figure 2.50. A portable, hand-operated stump grinder

Figure 2.51. A larger stump machine, lever-operated and pulled behind a truck

CHAPTER 3

The Tree Workers

Objectives

Chapter 3 describes the duties, responsibilities and requirements of the jobs of ground worker and climber.

1. Learn the responsibilities of the ground worker.
2. Become familiar with proper techniques of felling, bucking and limbing trees.
3. Be able to tie and use all the knots and hitches described in this chapter.
4. Be aware of the requirements of the job of tree climber.
5. Learn and understand all safety precautions outlined in this chapter.

The Ground Worker

The ground worker has a wide variety of duties and responsibilities. From his or her arrival at the job until the job is completed and the last pile of sawdust is swept up, the ground worker is always busy. The ground worker must be trained to operate and care for all equipment. Safety is the most important consideration in every task encountered.

Perhaps the primary responsibility of the ground worker is to aid the climber. The climber in the tree relies on the ground worker to send up saws, ropes, and other equipment (Figures 3.1, 3.2). The workers on the ground must make sure that the area is clear before the climbers can begin cutting. Often the ground workers must handle ropes on the ground when the climbers are lowering limbs.

The ground workers, as well as the climbers, must be familiar with all the knots and hitches commonly used in the trade. It is important to know how to tie and untie these knots and what they are used for (Figure 3.3).

Figure 3.1. The chain saw is sent up after the climber is set.

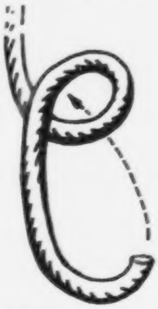
Figure 3.2. The saw is tied to the climber's line and then pulled up.

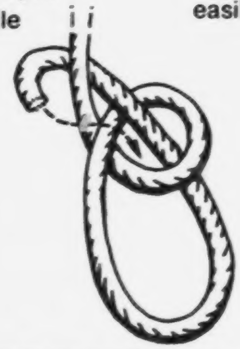
FIGURE 3.3. KNOTS AND HITCHES

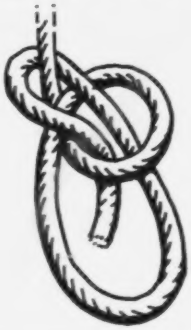
A. Bowline

Used:
- to attach snaps, hooks, etc. to ropes
- to attach climbing rope to saddle

The bowline will not slip or jam and is easily untied.



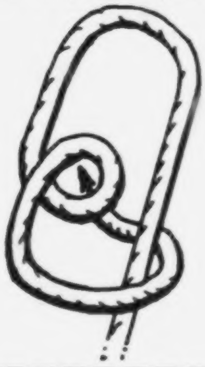


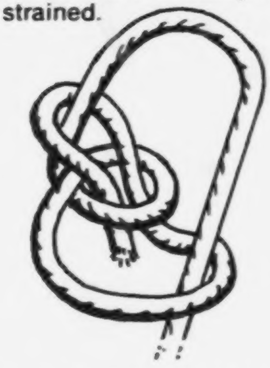


B. Running Bowline

Used:
- to tie off limbs for lowering
- as slip knot, can be pulled up the rope

The running bowline is similar to the bowline and is easily untied after being strained.

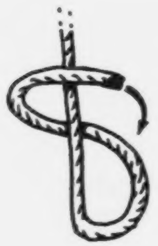


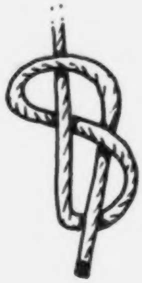


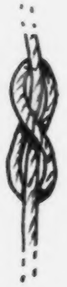
C. Figure 8

Used:
- to tie on the end of a rope to prevent its slipping through a knot or a block
- to identify the line to cut when rescuing a climber

The Figure 8 is easy to tie and may also be used to keep the strands of a rope from unlaying.



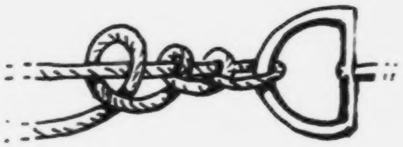




D. Half Hitches

Used:
- to secure rope temporarily
- sometimes in combination with other knots

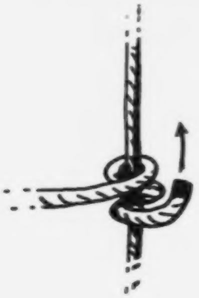
Half hitches are easy to tie and untie.

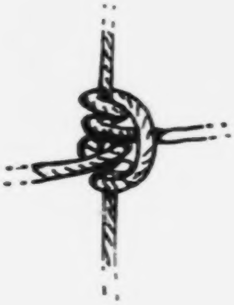


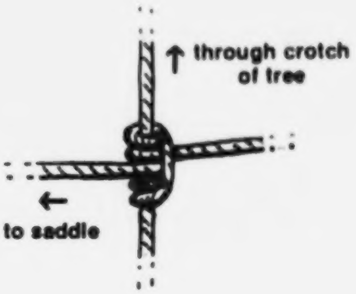
E. Tautline Hitch (Climber's Knot)

Used:
- by climbers as a rappeling knot when "tied in" to the tree

The tautline hitch must be kept tight.







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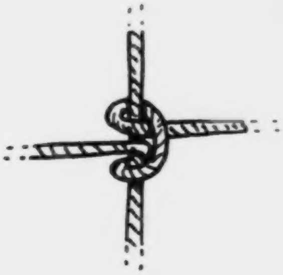
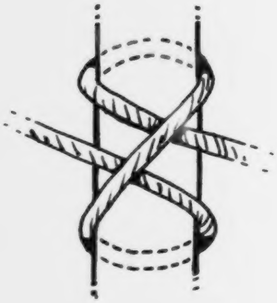
F. Clove Hitch

Used: • to fasten rope to limbs
- to tie on equipment to send up tree
- sometimes in combination with other knots

The clove hitch is frequently used by ground workers.

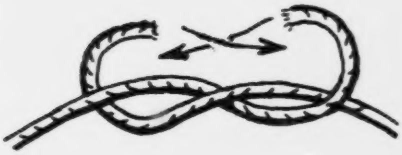


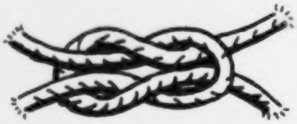


G. Square Knot

Used: • to join two ropes of equal diameter

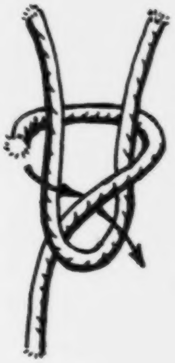
The square knot is easily untied after being strained.

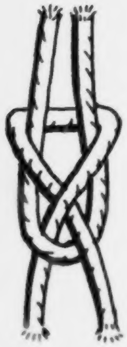




H. Sheet Bend

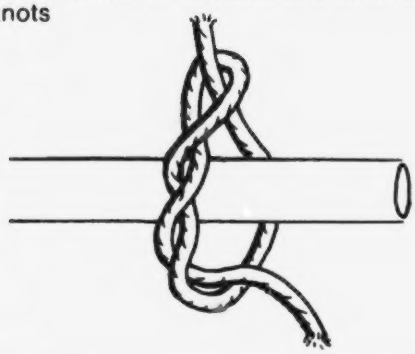
Used: • to join two ropes of different or equal diameter(s)

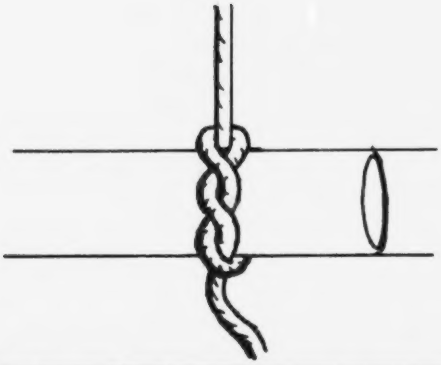




I. Timber Hitch

Used:
- to lower limbs from trees
- to hoist large limbs
- sometimes in combination with other knots





When the tree crew first arrives at the work site, the ground workers begin setting up for the job. This entails getting out the tools that will be used. The chain saws must be gassed and oiled. Chain tension on each saw should be checked and adjusted if necessary. The chains may need to be sharpened (Figure 3.4).

If a ladder is to be used, the ground worker can set it up while the climber gets ready. A worker should always steady the ladder while the climber ascends (Figure 3.5). Unsteady ladders are a major cause of accidents (Figure 3.6). If the climber is using a rope to ascend, the ground worker should anchor, or belay, the other end to insure the safety of the climber.

Once the climber is safely tied in, the next task for the ground worker is probably to send up certain tools. As demonstrated in Figure 3.7, a clove hitch is usually used to tie tools such as saws or pruning poles to the climber's line. The climber can then simply pull up the needed equipment. Before chain saws are sent up, they should first be started and shut off to make it easier for the climber to start the saw in the tree.

TREE FELLING, LIMBING AND BUCKING

Some trees can be cut down without the need of a climber. Tree felling requires the consideration of many factors. The lean of the tree, the wind direction, the shape of the crown, and the condition of the trunk — all must be taken into account. Rarely, a tree is situated in the open and can be dropped in the most favorable direction. More often, obstacles such as houses, power lines and other trees must be avoided. A "pull line" can be tied high in the tree to give leverage and allow workers to drop the tree in the desired direction.

Figure 3.4. Sharpening chain saws is one of the skills a ground worker should master.

Figure 3.5. Steadying the ladder for the climber.

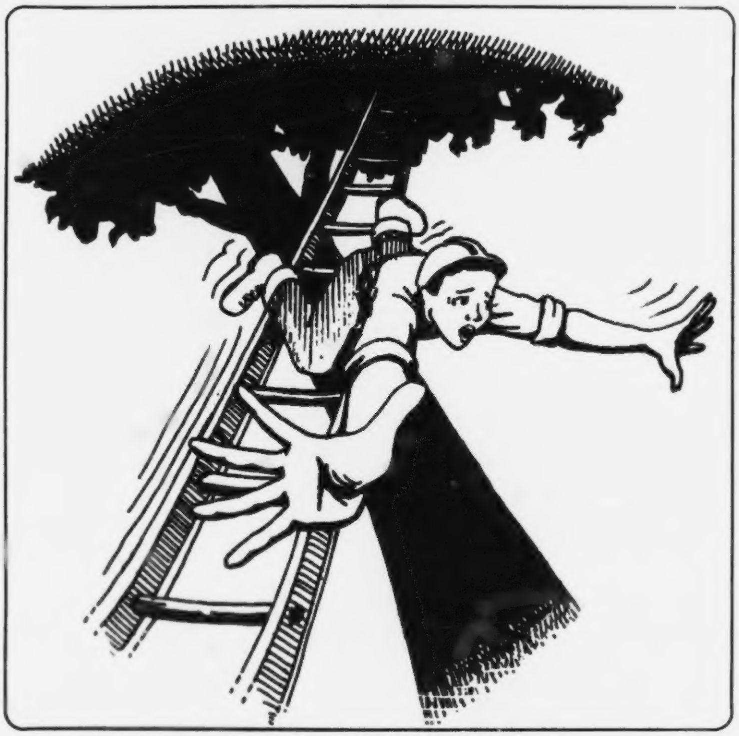


Figure 3.6. Unsteady ladders are a major cause of accidents.

Figure 3.7. Use a clove hitch to attach tools to the climber's line.

Once the direction of fall has been determined, the next step is to cut the notch. The notch is cut on the side of the tree facing the direction of fall (Figure 3.8). The top or downward cut should be made first. With the saw at full throttle, cut downward into the tree at about a 60° angle. The cut should go through approximately one-fourth of the tree's diameter. The bottom cut should be made level or parallel to the ground. When the bottom cut reaches the top cut, the slice of wood may fly out, so caution is in order (Figure 3.9).

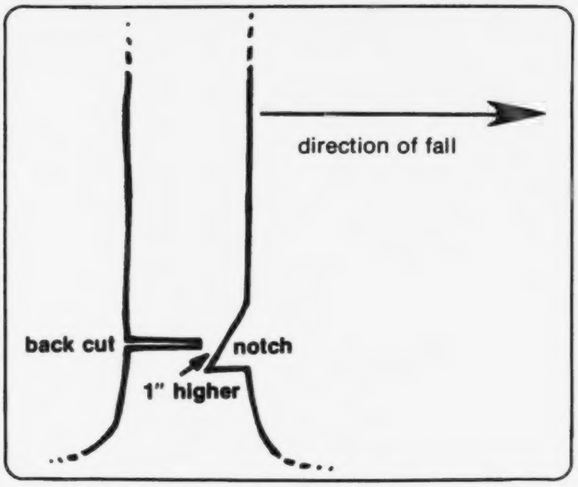


Figure 3.8. Cut the notch on the "fall" side of the tree.

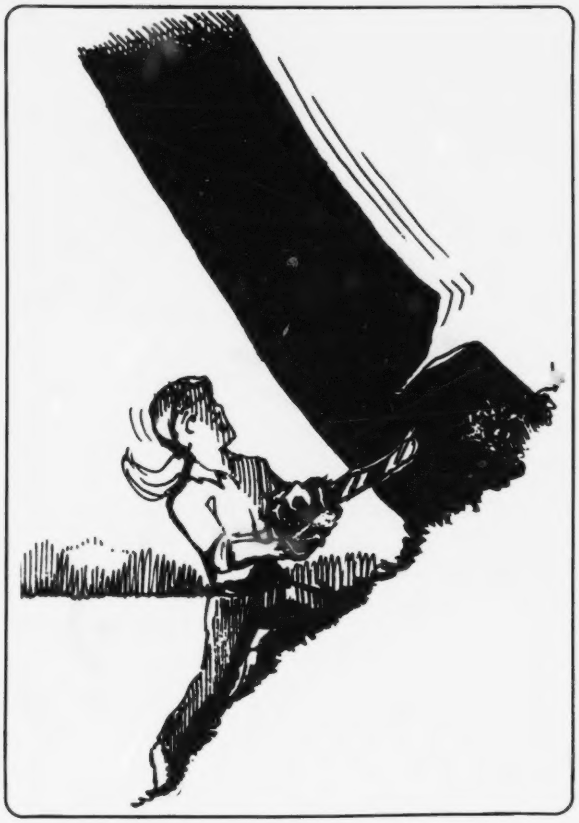


Figure 3.9. Mental errors are often the most dangerous.

The back cut or felling cut should be a level cut exactly opposite the notch on the other side of the tree. The back cut should be about one inch higher than the bottom cut of the notch. Before it reaches the notch, the saw should be removed and shut off, leaving a strip of uncut wood (Figure 3.10). This section of wood serves as a hinge. If the tree is cut all the way through, the worker will have less control over the direction of fall. If the tree has a rotten or hollow center, its fall will be less predictable. Leave more wood to serve as a hinge if possible.

When the tree falls, the butt end may kick back. The tree feller should have a preplanned escape route, and should move away without losing sight of the tree. Never attempt to move away with a running chain saw in hand.

Once the tree is on the ground, it must be limbed. This entails cutting off the smaller branches which will be chipped for mulch. It is safest to keep the trunk between the saw and the legs. In other words, cut the limbs on the far side first, then walk around and cut the other side (Figure 3.11). To avoid getting the saw pinched, try to predict before cutting which way the limbs will be under pressure. Some limbs will have to be cut from the bottom upward (Figure 3.12). It is helpful to cut the bottom limbs last. Caution is important in cutting these limbs since the tree may roll or drop to the ground when they are cut.

After the limbs are removed, the tree is ready for "bucking" or cutting into manageable-sized logs. In most cases the tree will be cut into logs for firewood, but more valuable trees may be left in lengths suitable for lumber. Bucking will be easiest if the tree is supported off the ground. This will avoid problems such as getting the saw pinched or nicking the ground. If the saw does get stuck in a cut, do not try to forcibly pull it out, as this could damage the guidebar. It is better to raise the log and open the cut. If the log is not supported, do not attempt to cut all the way through. Cut partially through and finish the remainder from the other side. Always begin a cut with the saw at full throttle. Never cut with the tip of the bar as this will result in kickback. Figure 3.13 illustrates the proper stance for good control of the saw and safety of the legs.

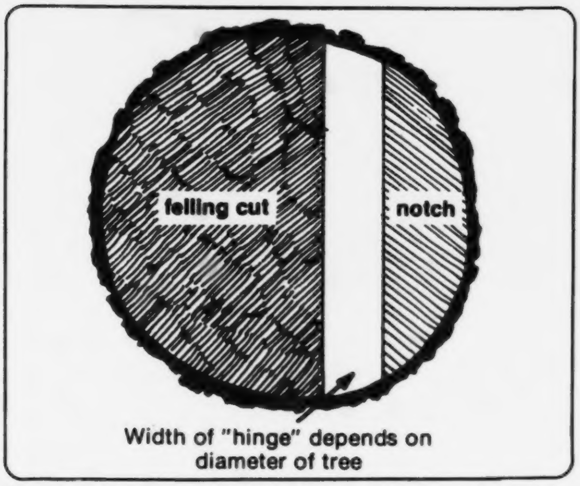


Figure 3.10. Do not cut the felling cut through to the notch.

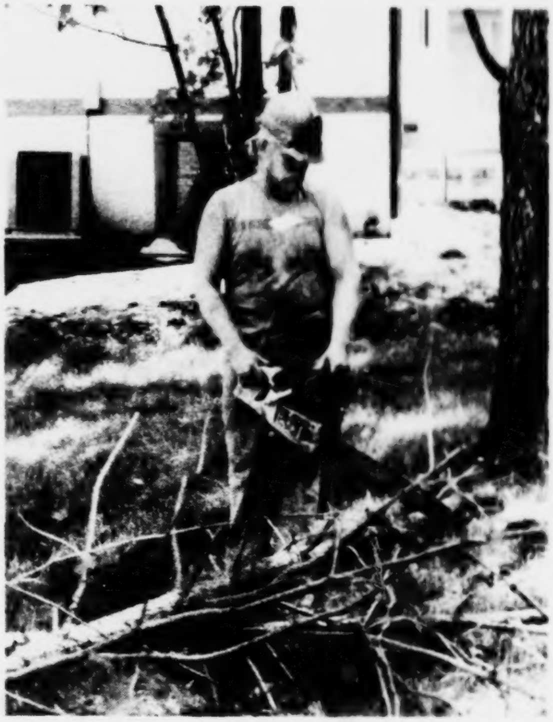


Figure 3.11. Keep the trunk of the tree between you and the saw when limbing a tree.

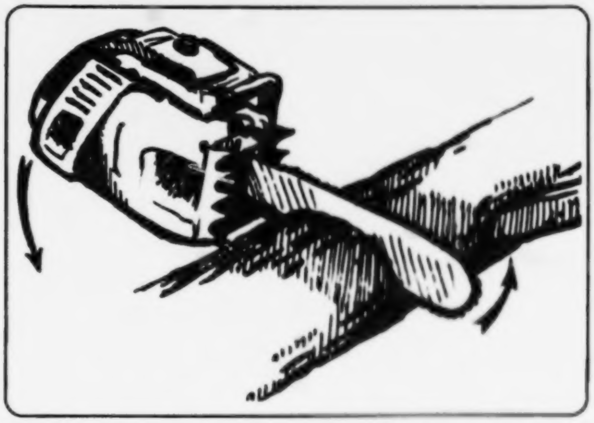


Figure 3.12. Cut with the tension of the branch to avoid getting the saw stuck.

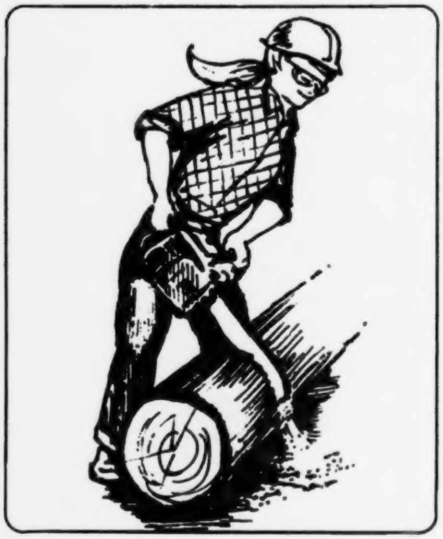


Figure 3.13. Keep legs out of the path of the saw. Brace the back of the saw against the upper leg to increase control.

CLEARING, BRUSH CHIPPING AND CLEAN-UP

Another duty of the ground worker is clearing limbs and brush from the work area (Figure 3.14). Limbs should be dragged or carried to the chipper out of the way of workers. Ground workers must stay alert to what the climbers are doing above (Figure 3.15). Ground workers should never attempt to clear brush from underneath a climber who is making cuts in the tree. In addition, ground workers must keep traffic and pedestrians from passing under workers in the trees. Most companies have warning signs and safety cones to block off the designated work area.

Ground workers are usually responsible for chipping brush. Brush chippers are dangerous pieces of equipment. The following precautions should be taken when operating them.

- Never operate a trailer-mounted chipper unless it is hitched to the truck or properly stabilized with the jacks down and wheels blocked (Figure 3.16).
- Do not chip brush under a tree that is being worked on.
- Move to the side of the feed chute when chipping brush to avoid whipping branches (Figure 3.17).
- Push small pieces of brush into the chipper with larger limbs. **Never** use your hands, feet or tools to push brush through.

Figure 3.14. Keeping the working area clear of brush

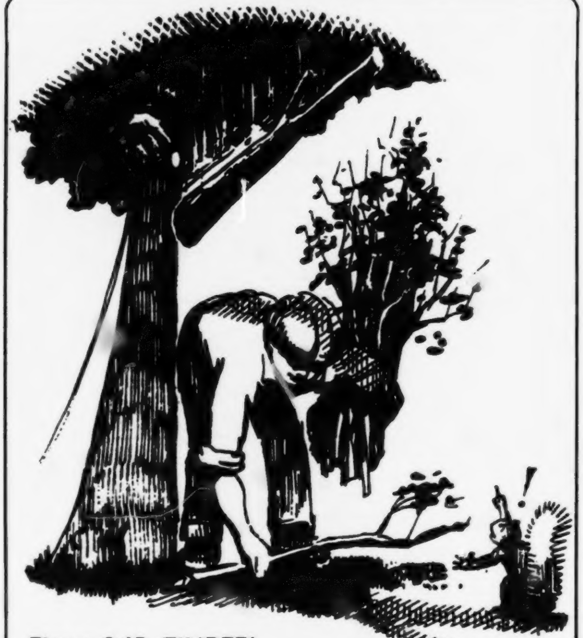


Figure 3.15. TIMBER!

Figure 3.16. A chipper hitched to the truck

- Stay away from the discharge chute while the chipper is in operation.
- Always remove the ignition key if the chipper is not in use and is unattended.
- Never leave the running chipper unattended.
- Never try to back the chipper without assistance, as it cannot be seen in the mirrors.
- Never attempt any repairs on the chipper while it is running.

The final task in every job is clean-up. The yard must be raked to clear it of all clippings, twigs and leaves (Figure 3.18). Then the sidewalks, driveway and street should be swept clean (Figure 3.19). Never run through the chipper any sweepings that may contain metal or stones. Always try to leave the area at least as clean and tidy as it was before the job was started.

Figure 3.17. Stay to one side when feeding brush into the chipper.

The Climber

Climbers have a great deal more responsibility than do ground workers. Climbers must be able to do all the work that ground workers do and quite a bit more. Most climbers started as ground workers. In addition to their training in tree climbing, climbers are skilled in pruning, rigging, cabling and diagnosing tree problems. A good climber is aware of the various characteristics of different types of trees such as wood strength and branch angles.

Many tree climbers have had formal training at professional or technical schools. They learn arboricultural skills including tree identification, insect and disease problems, safety practices, and tree physiology. In addition, they gain hands-on training in equipment operation and maintenance. This knowledge is coupled with tree climbing and maintenance skills, and the product is a good basic training background. (See Figure 3.20.)

Most companies prefer to hire climbers who have had some experience. An experienced climber should know how to thin, deadwood, and top and shape trees as well as how to rope down large limbs. Even climbers who have worked many years in the business will often say that they are still learning new techniques and methods.

It takes much more than knowledge and training to become a climber, though. There is still the physical factor. A climber must be in good physical condition to work in trees (Figure 3.21). Upper body strength is very important, as the climber may have to pull his or her own weight up

Figure 3.18. Rake the work area to leave it as clean as you found it.

Figure 3.19. A good clean-up job leaves a lasting good impression.

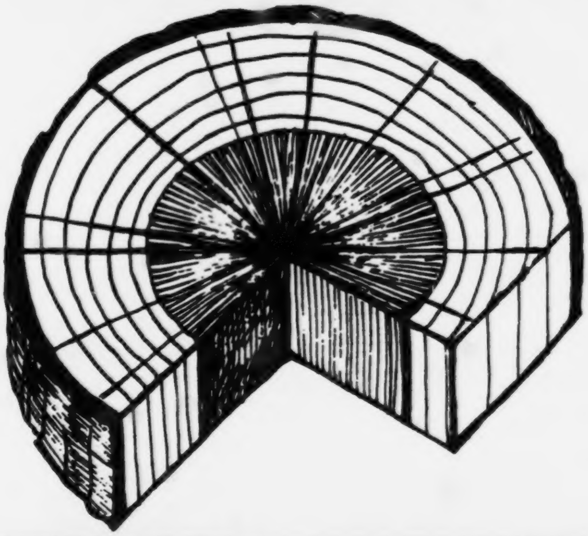
Figure 3.20. A rope and saddle do not make a climber. Many years of experience and training are required.

the tree. Agility, stamina and endurance are tested constantly in a routine work day.

Apart from all the factors described that go into making a successful tree climber, the most important asset is a healthy, positive state of mind. Tree climbing can be a dangerous and sometimes frightening profession. The climber must have a strong desire to do the job and cannot be afraid of heights. The climber must have his or her mind on the job and safety practices at all times. Otherwise the climber could endanger all other members of the crew.

So far the basic knowledge and capabilities required for the job of climber have been discussed. Skills and responsibilities of the climber will be dealt with in greater detail in later chapters. Tree trimming can be a complex and involved procedure which requires a combination of knowledge, common sense and experience. While some aspects can be learned from a book, others can be acquired only by actually doing the work.

Figure 3.21. Strength and agility are important in tree climbing.



CHAPTER 4

Basic Tree Anatomy

Objectives

The goal of this chapter is to acquaint the reader with the basic parts of a tree and provide some insight into the function of each major part.

1. Become familiar with the basic anatomy of a hardwood tree.
2. Gain an understanding of the functions of various plant parts.
3. Know why it is important to learn about the biological aspects of a tree.

Many of the jobs performed by a tree care worker require a basic understanding of the parts of a tree and how they function. Learning how to prune, fertilize, repair wounds, and transplant trees can all be made easier with a little knowledge of tree anatomy. Identification of trees and diagnosis of tree problems also depend heavily on knowledge of tree parts.

Roots

The roots of plants serve four primary functions. These are anchorage, storage, absorption and conduction. A strong, wide-spreading root system is required to support and anchor a large tree to keep it from blowing over in the wind. Root cells store carbohydrates and sugar complexes especially over winter while the tree is dormant. Roots are also the main point of absorption of water and vital minerals from the soil. These minerals are then conducted with the water up through the stem and throughout the plant.

Root elongation and differentiation occurs primarily at the root tips. Figure 4.1 shows the four zones of specialization in a root tip. The root cap protects the young root as it grows through the soil. The meristematic zone is an area of rapid cell division. Just beyond the meristematic zone is the region of elongation where new cells become larger. The region of differentiation follows. In this region the cells differentiate; that is, they mature and become specialized into conduction cells, storage cells or support cells. Externally, root hairs begin to develop in this region. Root hairs aid in water absorption by increasing the surface area of the root.

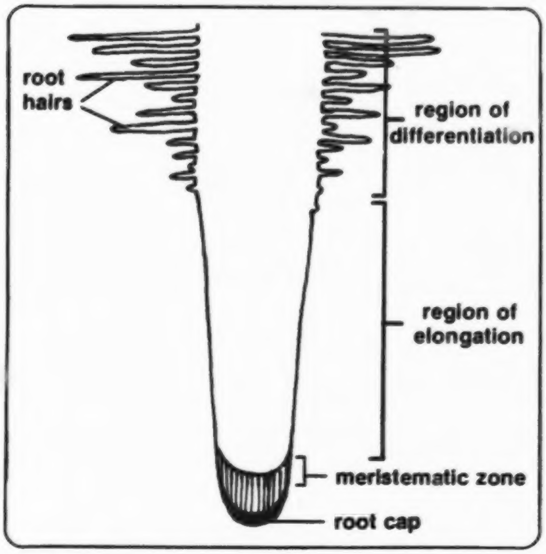

root hairs
region of differentiation
region of elongation
meristematic zone
root cap

Figure 4.1. The root tip is divided into four zones of specialization.

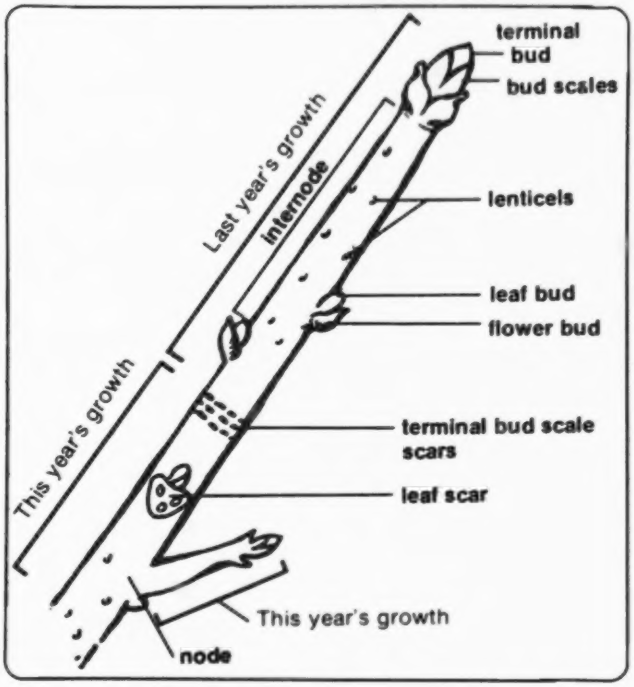

terminal bud
bud scales
Last year's growth
internode
lenticels
leaf bud
flower bud
This year's growth
terminal bud scale scars
leaf scar
This year's growth
node

Figure 4.2. The parts of a twig

Stems

The functions of a plant stem include support and conduction. The cells of the stem are specialized into either vascular (conductive) or support cells which strengthen the stem. Stems are different from roots in that stems have nodes (where bud initiation occurs) and internodes (Figure 4.2).

It is important to learn the parts of a twig and types of buds in order to understand the principles of pruning. The three main types of buds are terminal, lateral and flower buds. The terminal bud is the site of future branch elongation. Lateral (vegetative) buds produce leaves or lateral branches. Flower buds, or course, produce flowers and can usually be identified because they tend to be more rounded and plump than the other kinds. If the terminal bud is removed in pruning, growth is usually stimulated in the lateral bud closest to the cut. This stimulation of growth is under hormonal control.

Learning to distinguish between current growth and previous growth can be a good diagnostic tool. Measuring the amount of growth by twig elongation over several years often makes it possible to determine the time of an injury to a tree. Let's say a tree began declining three years ago. You may be able to determine what to do about it when you find out what happened to the tree that year.

The stem is composed of a variety of plant tissues. Figure 4.3 illustrates and locates some of these tissues. The young stem is bound externally by epidermal cells which protect the growing tissues. The cortex is composed of support tissue with some conductive tissue. The vascular tissue is composed of the phloem and the xylem. Phloem is the food-conducting tissue and xylem conducts water. The cambium is a layer of meristematic cells that give rise to new cells allowing the stem to increase in width. This is called secondary growth. The innermost section of the twig is the pith.

As the stem matures, the outer bark is formed. Cork cambium forms cork cells which make up much of the bark. The bark actually includes everything from the phloem out (Figure 4.4). Lenticels permit the exchange of gases through the otherwise-impervious corky layer.

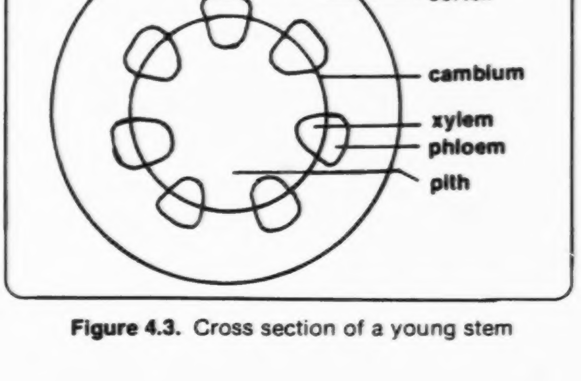

epidermis
cortex
cambium
xylem
phloem
pith

Figure 4.3. Cross section of a young stem

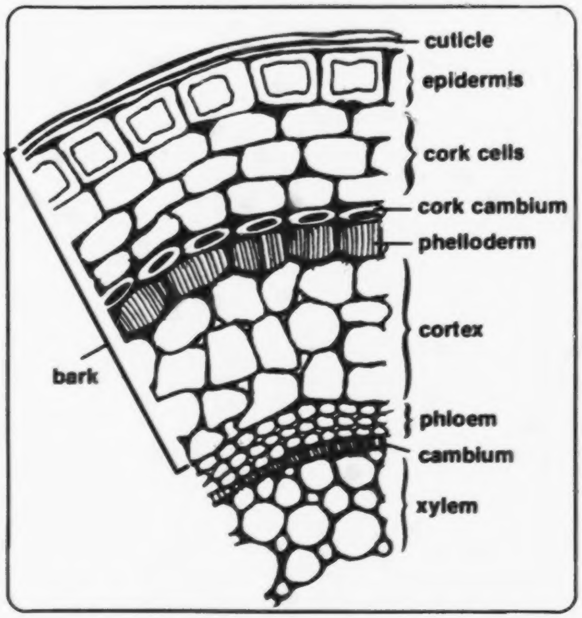

cuticle
epidermis
cork cells
cork cambium
phelloderm
cortex
bark
phloem
cambium
xylem

Figure 4.4. Partial cross section through the maturing stem of a hardwood tree

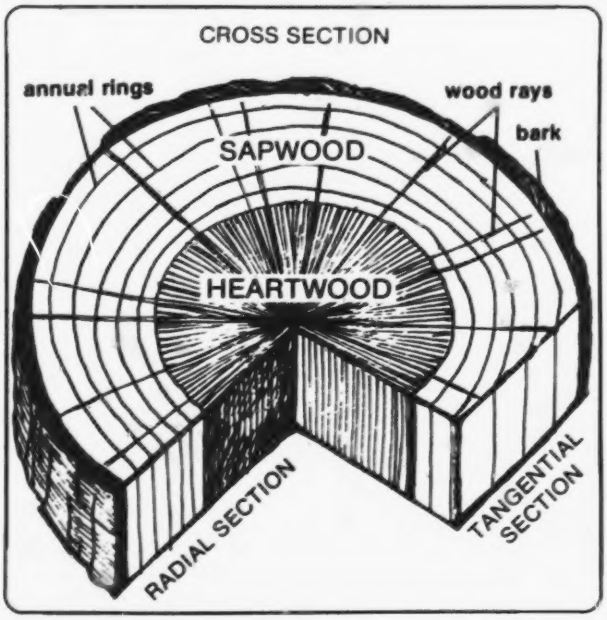

CROSS SECTION
annual rings
wood rays
bark
SAPWOOD
HEARTWOOD
RADIAL SECTION
TANGENTIAL SECTION

Figure 4.5. Wood section of a hardwood tree

A cross section through a tree as illustrated in Figure 4.5 reveals different areas and characteristics of the wood. Annual growth rings are clearly visible because of the rapid growth rate of early wood (spring wood) relative to that of late wood (summer wood). Annual rings can be counted to determine the age of the tree. The width of each ring gives an idea of the growing conditions of that year. Wood rays are cells that run across the grain carrying nutrients or storage materials laterally in the tree. Figure 4.5 also shows the three ways to cut sections of wood. These are tangential section, cross section and radial section.

Leaves

The leaves (foliage) of the tree are the chief sites of photosynthesis and transpiration. Most of the "food" the plant needs is produced in the leaves. Water transpired from the leaves helps maintain the water transport system. **Transpiration** is the loss of water through the foliage.

A cross section through a leaf reveals various layers of cells (Figure 4.6). The cuticle, the outermost part of the epidermis, is composed of a waxy material which helps prevent desiccation (drying out) of the leaf. Stomata, also located in the epidermis, are small openings located primarily in the lower side of the leaf. Stomata control the exchange of gases — oxygen out and carbon dioxide in. Guard cells, by expanding and contracting, regulate the opening and closing of the stomata. The leaf vein is composed of vascular tissue which conducts food and water throughout the leaf.

Leaves may be arranged on the stem in several ways (Figure 4.7). The most common arrangements are **alternate** and **opposite**. Maples, ashes, dogwoods, buckeyes, and horsechestnuts have leaves arranged opposite on the stem. Most other trees have alternate leaf arrangements. Leaves may be one (simple) or with many leaflets (compound) on each petiole ("leaf stem") (Figures 4.8, 4.9).

Leaf shape is largely under genetic and hormonal control, but it is also influenced by

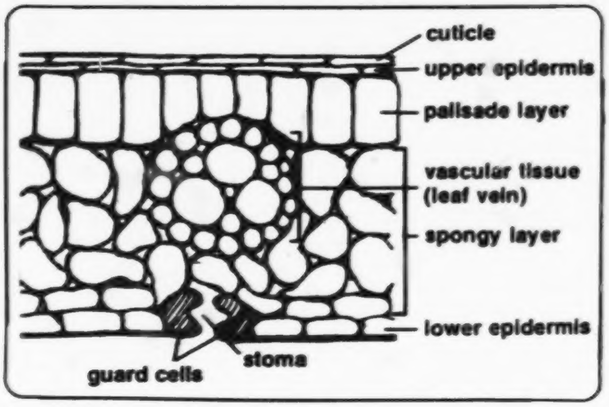

cuticle
upper epidermis
palisade layer
vascular tissue (leaf vein)
spongy layer
lower epidermis
stoma
guard cells

Figure 4.6. Cross section through a leaf blade

environmental conditions such as light and moisture. Some leaves are modified into bud scales, spines, tendrils or other plant parts. Leaf characteristics are often used in identification of plants. Leaf morphology (shape), venation patterns (Figure 4.10), and margin formation (Figure 4.11) are some of the important identification characteristics.

Deciduous trees are known in the fall for their color and losing their leaves. Leaf drop is caused by cell changes and hormones in the abscission zone at the base of the leaf petiole. Fall foliage color is due to expression of pigments other than chlorophyll. Shorter days and temperature changes trigger the accumulation of sugars and a decrease in chlorophyll production in the leaves, allowing these pigments to be expressed. These pigments are anthocyanins (reds and purples) and carotenoids (yellows, oranges, and reds).

(continued on page 39)

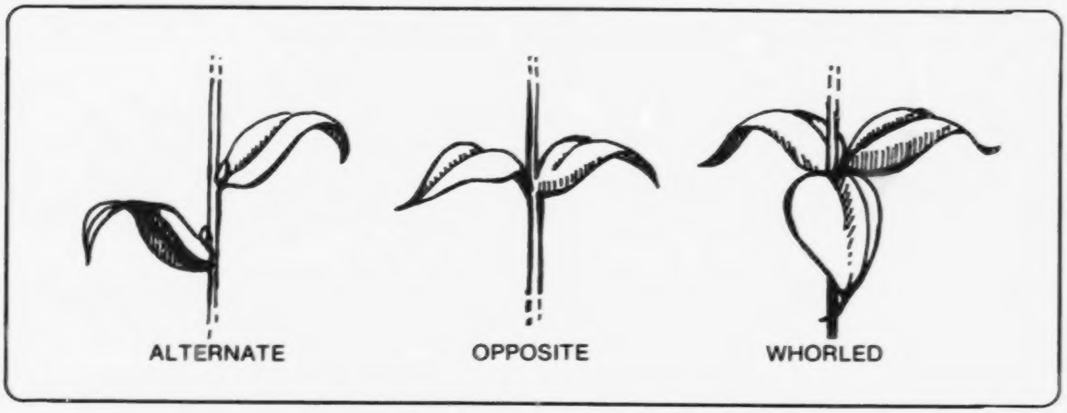

ALTERNATE
OPPOSITE
WHORLED

Figure 4.7. Arrangements of leaves on the stem

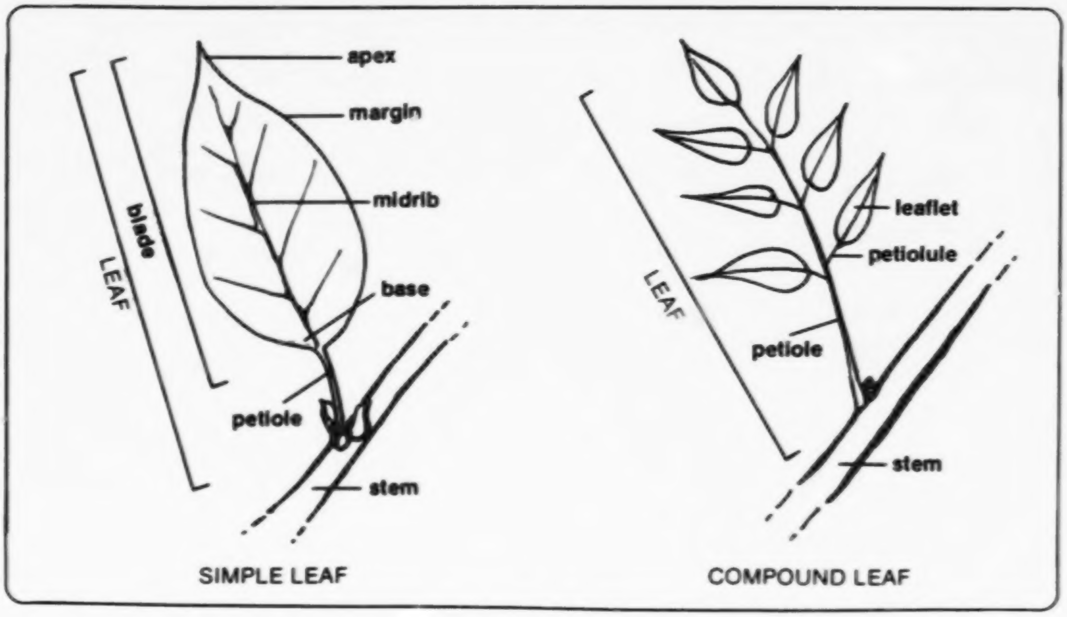

apex
margin
midrib
base
petiole
stem
blade
LEAF
SIMPLE LEAF
leaflet
petiolule
petiole
stem
LEAF
COMPOUND LEAF

Figure 4.8. Contrast of a simple with a compound leaf

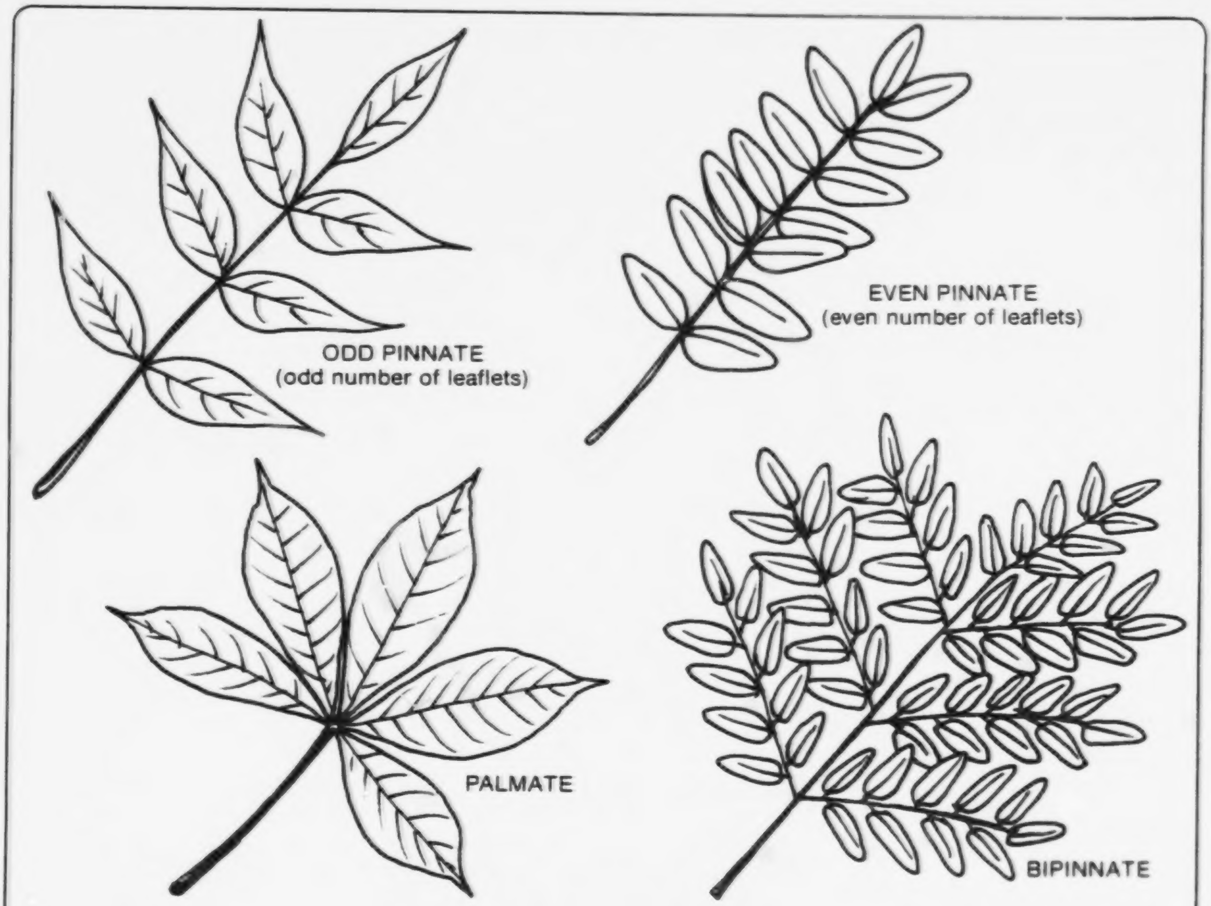

ODD PINNATE
(odd number of leaflets)
EVEN PINNATE
(even number of leaflets)
PALMATE
BIPINNATE

Figure 4.9. Types of compound leaves

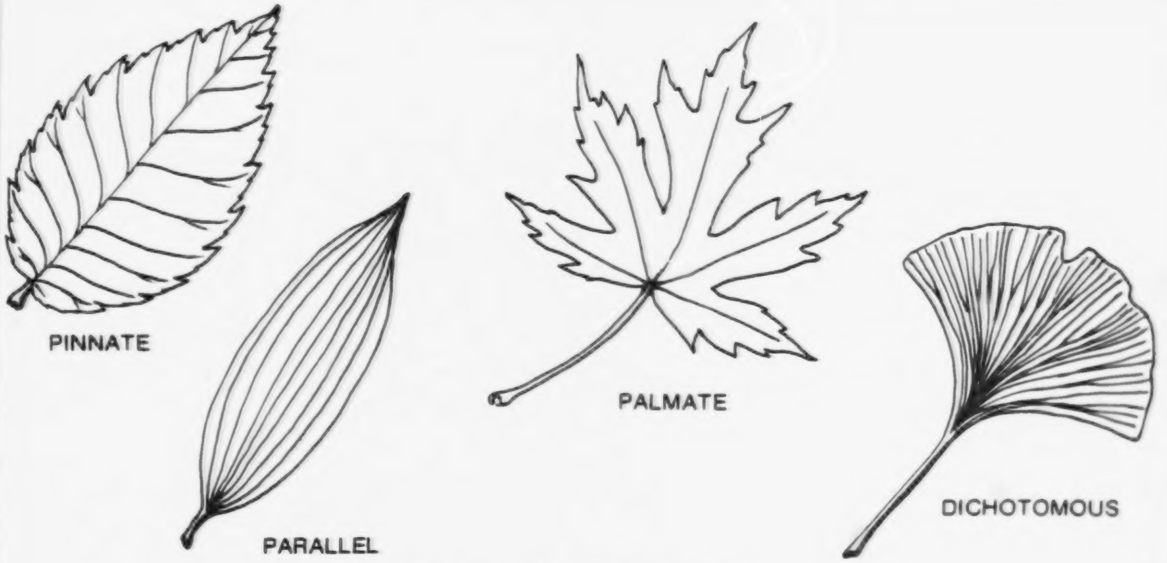

PINNATE
PARALLEL
PALMATE
DICHOTOMOUS

Figure 4.10. Types of venation

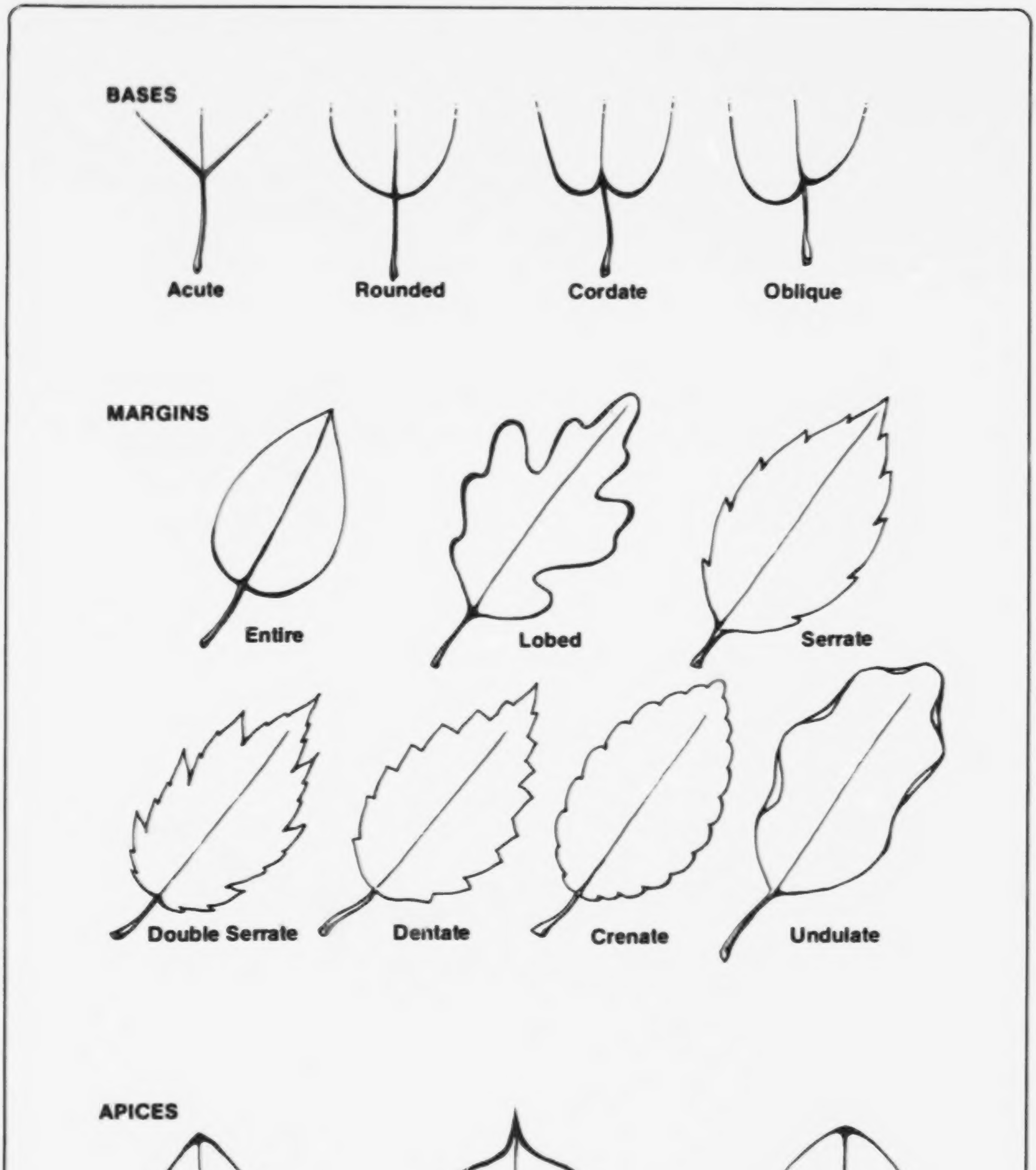

BASES
Acute
Rounded
Cordate
Oblique
MARGINS
Entire
Lobed
Serrate
Double Serrate
Dentate
Crenate
Undulate
APICES
Acute
Acuminate
Obtuse

Figure 4.11. Types of leaf bases, margins and apices.

PHOTOSYNTHESIS AND THE TRANSPORT SYSTEM

Photosynthesis is the process by which light energy is used by plants to produce "food" — organic sugar compounds. The energy derived from these compounds is used by the plant to power other systems such as nutrient transport and respiration. **Respiration** is the process by which organic sugar compounds are broken down to provide the necessary energy. By contrast, **transpiration**, as already defined, is the process by which matter is drawn up through the stem and roots and is lost through the leaves. Although greatly simplified, these definitions do essentially describe the basic plant functions. Figure 4.12 summarizes photosynthesis and the transport system.

Flowers and Reproduction

The flower contains the basic reproductive organs of most trees and shrubs. Angiosperms, plants with seeds borne in an ovary, include the common trees that we work with. All hardwood trees do bear flowers, though we do not think of oaks and maples as flowering trees.

Reproduction comes as a result of the union of sperm cells (contained in the pollen from male flower parts) with the egg (produced and remaining in the ovary of the female flower parts). Most trees are **monoecious**; that is, they have both male and female flowers on the same tree. A few are **dioecious**, with separate male and female trees. A dioecious, male tree will not produce fruit or seeds. There are many types of flowers and they

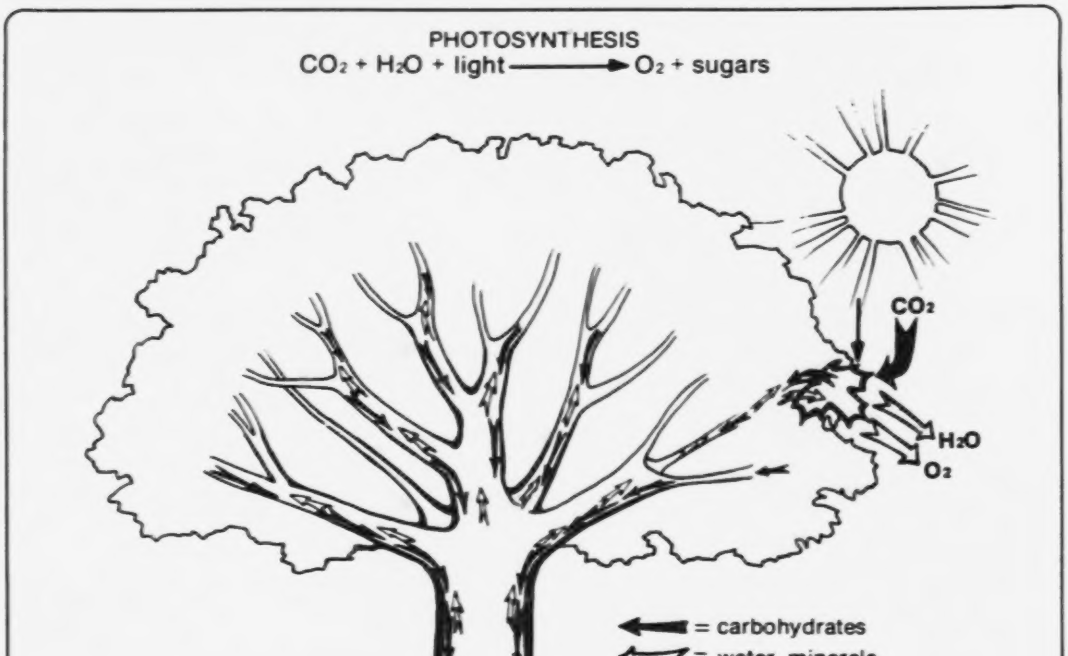


Figure 4.12. Summary of photosynthesis and transport system

are divided into categories by what parts they contain or lack. A complete flower contains all four main parts: petals, sepals, stamens and pistils (Figure 4.13). A **perfect** flower is bisexual, containing both male and female parts. An **imperfect** flower is unisexual, containing either male or female parts.

Following pollination and fertilization, an embryo is formed within the ovary. As it matures, this ovule develops into the seed. Trees and other plants reproduce naturally by seed. Horticulturists, however, have learned and commonly use alternate propagation methods such as grafting and rooted cuttings to reproduce plants. Whatever propagation method is employed, the basic cycle of seedling to seed remains the same.

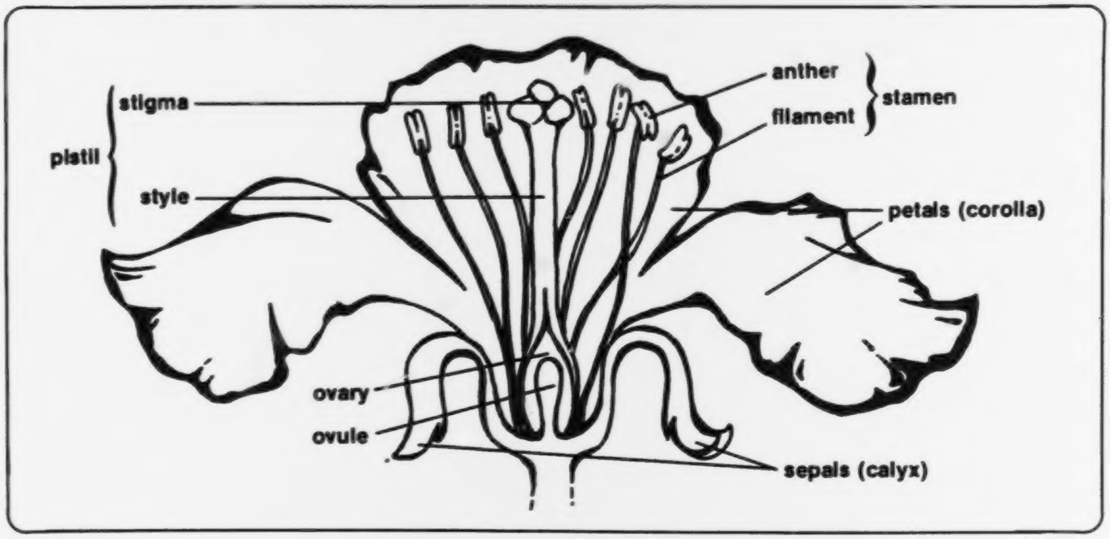
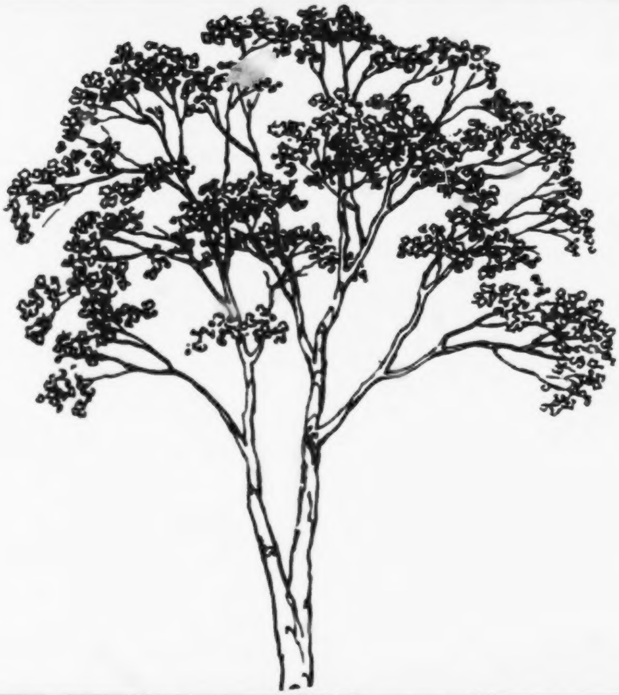

stigma
pistil
style
anther
filament
stamen
petals (corolla)
ovary
ovule
sepals (calyx)

Figure 4.13. Parts of a complete flower



CHAPTER 5

Pruning

Objectives

The purpose of this chapter is to introduce the basic principles of pruning.

1. Gain an understanding of the reasons for pruning.
2. Learn what parts to remove when pruning a plant.
3. Become familiar with the general procedures for pruning.

Reasons for Pruning

Pruning may be defined as the removal of plant parts to improve the health or appearance of the plant. Some of the reasons for pruning are as follows:

1. To remove dead or damaged plant parts.
2. To preserve plant health by removing diseased and insect-damaged parts.
3. To reduce the safety hazards of weak or broken limbs.
4. To maintain the shape of the plant.
5. To promote better branch structure for the plant as it matures.
6. To promote new growth or rejuvenate old, declining plants.
7. To restrict plant growth.
8. To remove unsightly sucker growth.
9. To improve future flowering or fruiting.
10. To create special effects (Figure 5.1).
11. For clearance from utility lines.

Figure 5.1. These trees have been pruned to create an archway.

In the landscape it is often necessary to prune plants to reduce or restrict growth. All too often plants are inappropriately chosen for planting around a home. They tend to outgrow the beds, hide the windows, and eventually "engulf" the house. The best preventive measure is to choose plants that will not grow too large. If this is not done, however, trees and shrubs must be "contained" by pruning.

Large shade trees are not usually trimmed to restrict growth. More often, pruning large trees involves the removal of dead wood, diseased limbs, and broken branches. In most cases tree trimming is of a corrective or preventive nature. Trees may be thinned to reduce storm damage or increase light penetration to plants or lawns below.

When to Prune

Many people worry that if they prune at the wrong time of year they may end up killing or damaging the plant. Generally, it makes little difference what time of year pruning is done, although some plants have recommended seasons or timing for pruning. Pruning at the "wrong" time of year will not kill the plant, but it can temporarily restrict flowering or growth.

Probably the overall best time of year to prune most plants is late winter, before the spring's new growth begins. Some trees, like maple and beech, "bleed" if pruned in the spring. This sap flowing from the cuts does not really damage the plant. Pruning of some plants just *after* the new spring growth can cause dwarfing or stunting of later growth. Since the plant has just expended much of the food stored in its roots to produce the new flush of growth, any additional growth stimulated by pruning will be limited. A common recommendation is to prune flowering plants right after they have flowered to avoid removing next year's flower buds. Also, it is a good idea to limit late summer pruning of certain less hardy plants. New succulent growth produced late in the season may not have sufficient time to harden off before winter.

What to Prune

When one is first learning how to prune, it is difficult to know what branches to cut. With a little knowledge and experience, pruning will become second nature. Most of the principles of pruning are simply common sense. Here are a few rules of thumb for pruning trees and shrubs.

1. Remove all dead or damaged branches.
2. Remove crossed branches (Figure 5.2).
3. Remove branches that grow toward the interior of the plant (Figure 5.3).

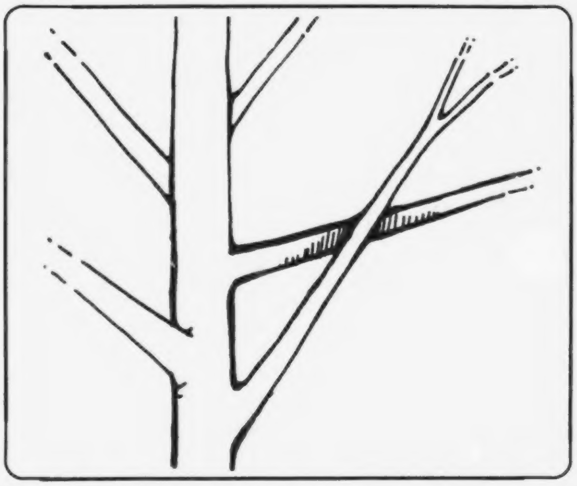


Figure 5.2. Branches that cross may damage each other and detract from the appearance of the tree.

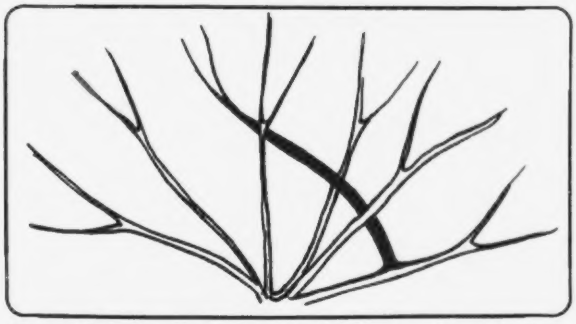


Figure 5.3. Remove branches that grow through the middle of the plant.

4. Prune suckers and water shoots (Figure 5.4).
5. Cut off any old stubs.

Figure 5.4. Remove suckers and water shoots.

Equipment

Most of the equipment used by tree workers has already been discussed. (See Chapter 2.) However, there are still a few points to be made. One of the most versatile pieces of pruning equipment is a pair of **hand pruners** or hand pruning shears. Properly sharpened hand pruners will easily cut ¼- to ½-inch twigs. If the cut cannot be made without twisting, the twig is too large for the tool being used. There are two types of hand pruning shears (Figure 5.5). Double-cut or scissor-cut hand pruners have an upper flat blade and a lower hook blade. These pruners tend to cut very efficiently. Anvil-type clippers are less expensive, but also less efficient; they do not leave as clean a cut as double-cut hand pruners.

Figure 5.7. A clean cut is obtained by cutting upward with hand pruners.

Hedge shears are also commonly used for pruning shrubs (Figure 5.6). They are perhaps the most overused and misused pruning tools. Hedge shears are the tools used to clip shrubs and hedges into formal shapes. They are used to create unusual shrub shapes like gumdrops, bowling pins and match boxes along the front of houses. Although this is certainly a viable pruning option, the trend today is to prune plants in a manner that maintains or enhances their natural form.

Proper Pruning Techniques

All cuts should be "clean" without any peeling bark or frayed edges. This requires sharp tools and proper cutting technique. Usually the main cutting blade should cut upward in order to make a good cut with hand pruners (Figure 5.7), loppers or pole pruners. Never twist or tear off a branch. With the correct tool, any cut can be made easily without tearing.

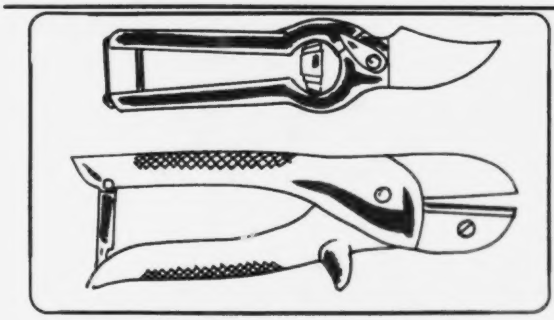


Figure 5.5. Hand pruning shears
A) Double-cut
B) Anvil-type

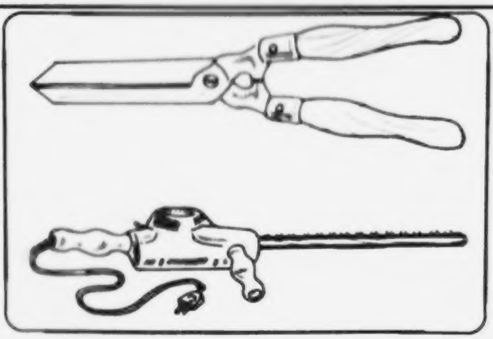


Figure 5.6. Hedge shears

The placement of the cut is the most critical factor in pruning. The cut must be made close to the main limb without cutting into the branch collar or leaving a stub. Figure 5.8 shows the correct placement of the cut. The best way to achieve the desired cut is to cut upward from point A to point B. The angle is equal and opposite to the angle formed by the branch bark ridge. The branch bark ridge is simply a rough, raised area in the bark formed at the crotch. Never cut branches through the branch collar and flush with the parent stem (Figure 5.9). Doing this would inhibit the tree's natural ability to close the cut and block off decay. A little practice and experience will help in locating the branch bark ridge and the branch collar on many different types of trees. Figure 5.10 shows two incorrect cuts.

When working with larger limbs, it is necessary to remove the main weight of the limb before making the final cut. Figure 5.11 shows the cuts that are used in pruning a large limb. The lower "undercut" is made to prevent peeling down of the branch into the main trunk (Figure 5.12). Never cut too deep in the undercut or the saw will get pinched. The second cut removes the limb.

Pruning Trees to Direct Growth

Early pruning of young trees is important to direct growth and establish a strong branch scaffold. The strength of the branch structure is dependent upon the angles and spacing of the limbs. Naturally this will vary with the growth habit of the tree. Pin oaks and sweetgums have a strong conical shape with a central leader. Other trees, such as lindens and Bradford pears, are densely branched, often without a central leader.

Branches that are to be part of the permanent branch structure should be selected for structural

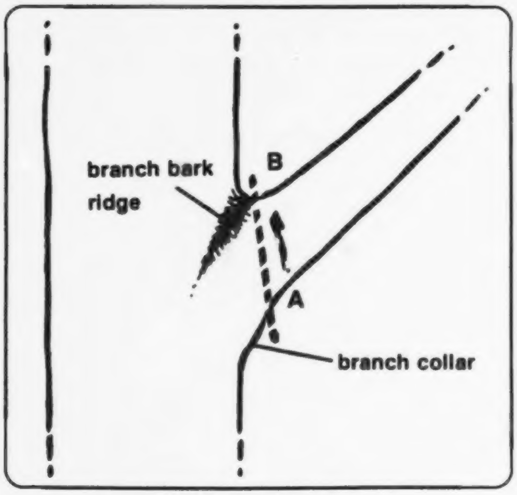


Figure 5.8. Locate the correct line for the cut.

Figure 5.9. Never cut through the collar of the branch.

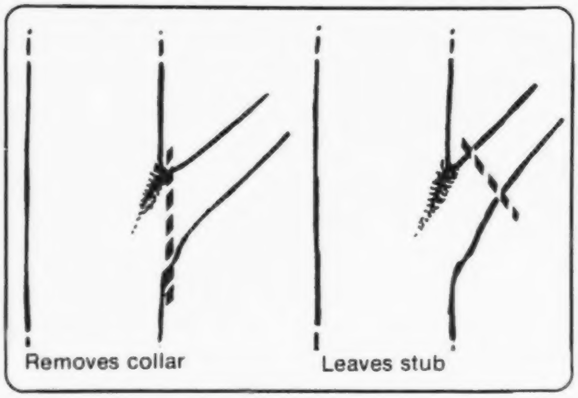


Figure 5.10. Incorrect branch cuts

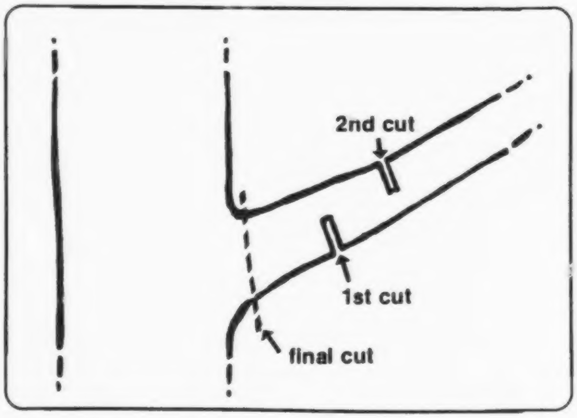


Figure 5.11. Three cuts are used when removing large limbs.

integrity. Prune branches with very narrow crotch angles as they may lead to splitting. The spacing of limbs, both vertically and radially in the tree, is also important. Branches spaced too close together not only are less appealing visually, but may "break up" during a storm. Generally the leader in a tree is not pruned back unless multiple stemmed plants are desired, or if the leader has become too dominant. If a tree has more than one leader, one should be selected and the others removed. (See Figures 5.13, 5.14, 5.15, and 5.16.)

Drop Crotch Pruning

Topping or "heading back" is the most common method of reducing the height of a tree. In order to direct growth and reduce unattractive suckering from top cuts, the drop crotch method should be used (Figure 5.17).

Generally, not more than one-third of the total canopy area should be removed in a single pruning operation. Cuts should be made back to a lateral, or side branch, no less than one-third the diameter of the cut. Cutting large limbs back to small suckers often results in further dieback of the limb.

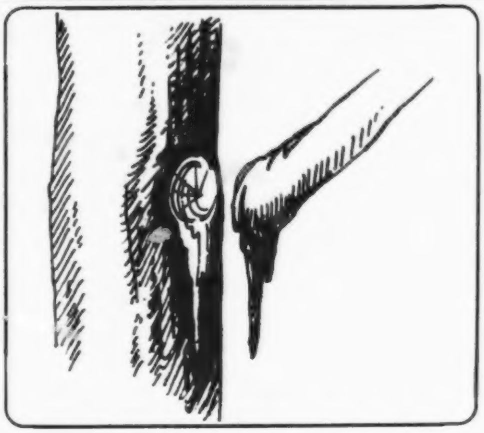


Figure 5.12. Use of incorrect technique can result in the bark being stripped from the parent stem.

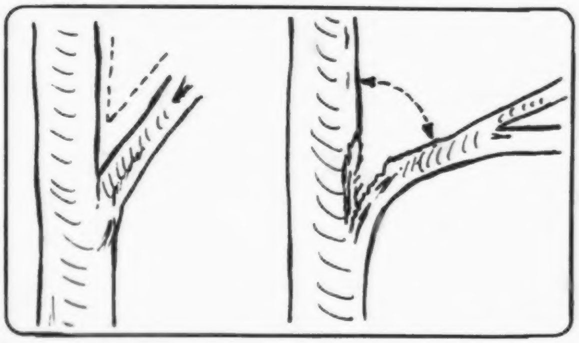


Figure 5.13. A branch with a narrow angle of attachment may not be sound.

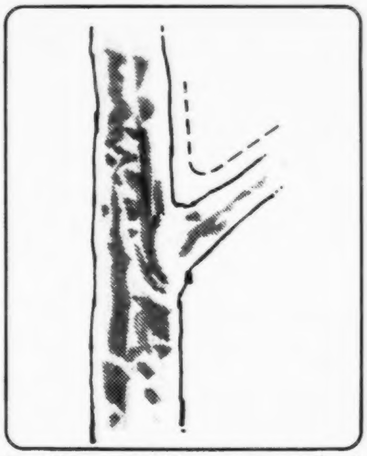


Figure 5.14. When possible, select scaffold branches with wide, strong angles.

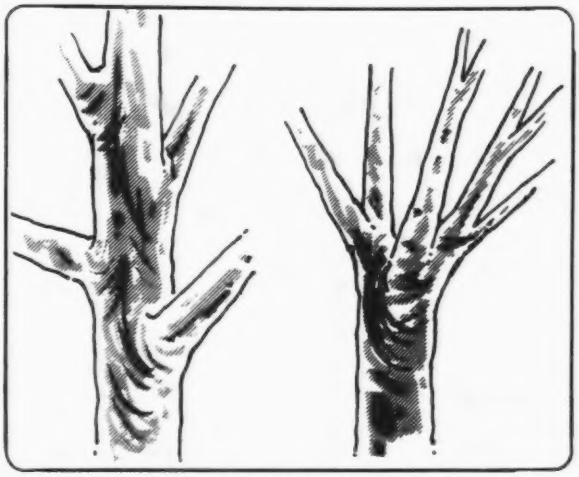


Figure 5.15. Well-spaced branches have stronger attachments than those growing close together or in a cluster.

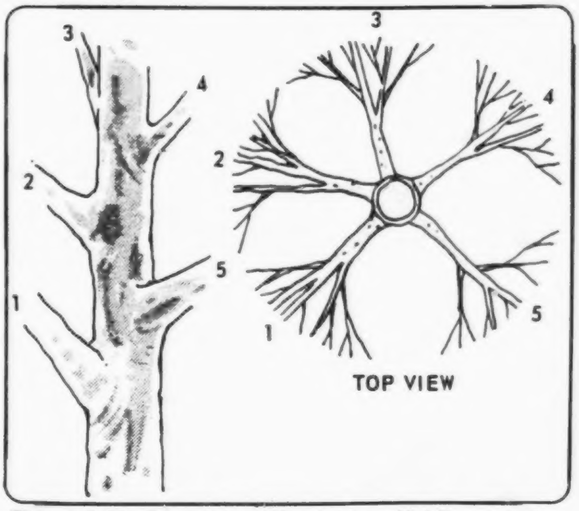


Figure 5.16. Branches with good scaffolding require proper vertical and radial spacing on the trunk.

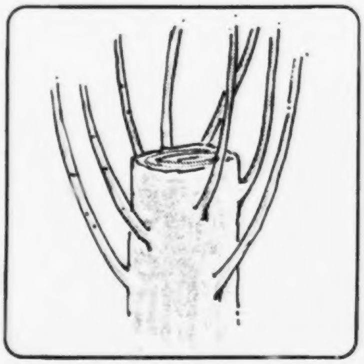


Figure 5.17. Topped trees produce vigorous watersprouts.

Figure 5.18 shows a tree that has been pruned using the drop crotch method. Notice that the standard rounded shape has been maintained. Flat-topped trees are very unappealing to the eye.

There are two steps in making the cuts for drop crotch pruning. First, the weight of the limb is removed several inches above the lateral (Figure 5.19). Then the final cut is carefully made diagonally just above the lateral — sufficiently close to it without cutting the branch bark ridge or leaving a stub.

Even when done correctly, drop crotch pruning takes away from the natural form of the tree and may reduce its functional life. For these reasons this type of pruning is used only under certain special circumstances:

1. Tree interference with utility lines.
2. Unusual or rapid tree growth.
3. Reduction in height of soft-wooded trees to reduce the safety hazard from breaking.
4. Reduction in the canopy of a tree when the root system has been severely damaged or removed.
5. Specific topiary training or dwarfing.

Treatment of Wounds

Lesions in a tree may be caused by splitting of branches or by any kind of mechanical means such as collision from a car or lawn mower. Often the bark is crushed or torn from the wood of the tree. Such wounds should be treated as soon as possible.

First the loose or damaged bark should be cut away. Using a sharp knife, cut around the wound, smoothing the irregular edges (Figure 5.20). This is called bark tracing or wound tracing. It is very important not to cut into the wood. Remove as little

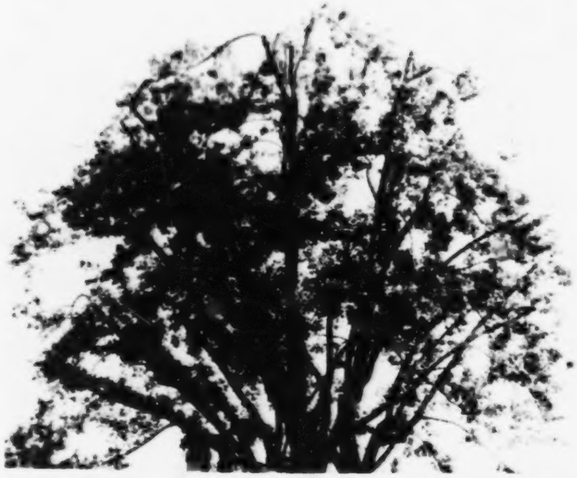


Figure 5.18. In heading back, all cuts are made at laterals and the shape of the tree is maintained.

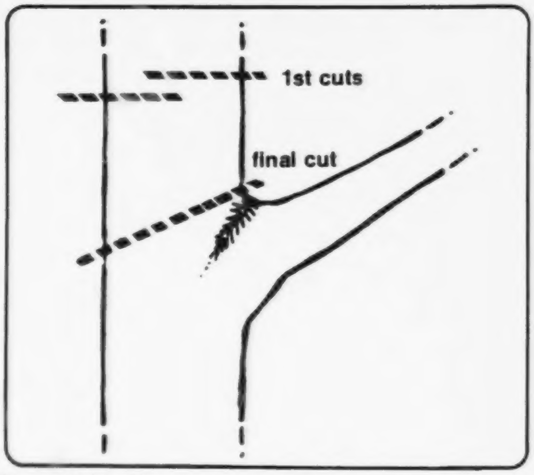


Figure 5.19. The final cut should run diagonally just above the branch bark ridge.

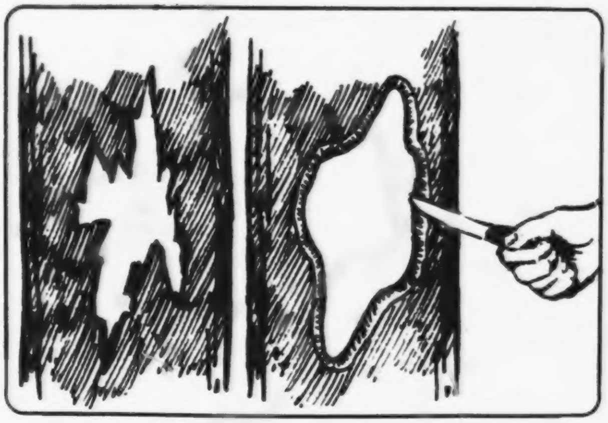


Figure 5.20. When tracing a wound, remove as little as possible, leaving a smooth edge for closure.

bark as possible. The shape of the final wound is not important but should be smooth and curved, containing no jagged, sharp corners.

There has been lively debate as to the merit of using wound dressings on pruning cuts and tree wounds. Increasingly, most research indicates that wound dressings do not keep out insects or diseases and do not aid in wound closure. Therefore, dressings should be applied only to color the wound — for purely cosmetic purposes. A thin layer of a material non-toxic to the cambium may be used.

Sterilization of Tools

When tools are used on a tree known to be diseased, it is often recommended that they be sterilized between cuts and certainly before use on another tree. This helps reduce the spread of disease organisms. Tools may be sterilized with a 70% methyl alcohol (methanol) solution. There remains some doubt as to whether certain diseases can be transmitted via pruning tools and whether alcohol treatment is effective. But tool sterilization for diseased trees is still a recommended procedure in most references.

Pruning Conifers

Conifers sometimes require different pruning techniques. The timing is usually more important than for deciduous plants. Generally, conifers are pruned while they are dormant, although there are some exceptions.

Pines are pruned in the spring just as the new "candle" growth has expanded (Figure 5.21). Candles may be cut halfway to create dense foliage. Pruning at this time will not prevent bud formation the following year. Pines form buds only in actively growing (twigs with needles) parts of the plant.

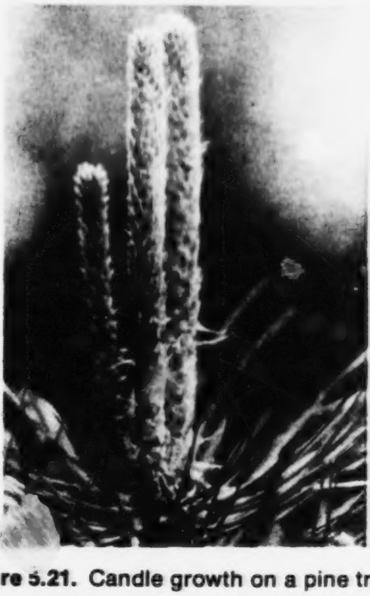


Figure 5.21. Candle growth on a pine tree.

Regular pruning techniques apply to the pruning of branches on coniferous trees. Keep in mind that pruning late in the season will result in no growth the following season where buds have been removed. Generally coniferous trees have a single central leader. If a second leader develops, it should be removed. (See Figures 5.22 and 5.23.)

Spreading evergreen plants may be pruned to restrict growth and maintain shape. Figure 5.24 shows how these plants might be pruned. Pruning according to natural growth shape is recommended over extensive shearing except where formal, compact forms are desired. An ideal time for pruning evergreens is at Christmas so that the clippings may be used in decorating.

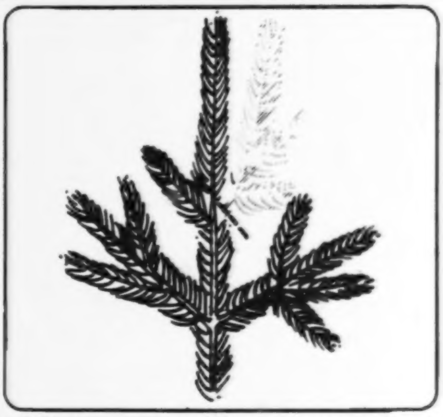


Figure 5.22. Remove multiple leaders on spruce and pine, leaving the best one to become the new central leader.

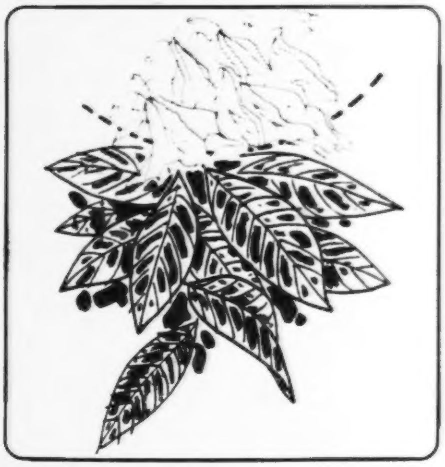


Figure 5.23. Snap or cut out dead flowers of rhododendron, being careful not to damage new shoot growth.

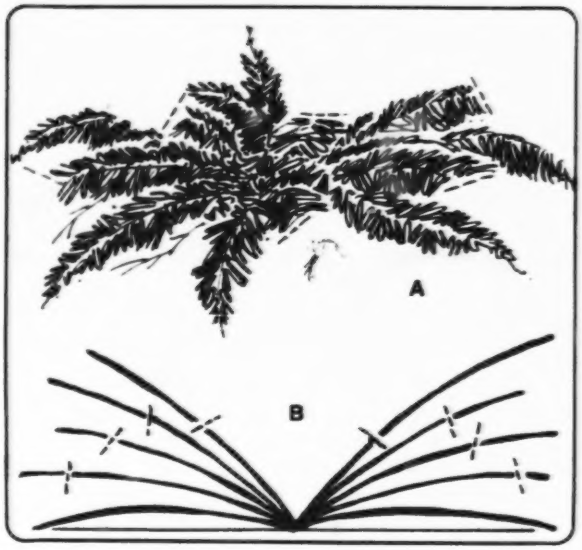


Figure 5.24. Prune spreaders by cutting back longer, upper branches, as in A. Long branches should be cut back from a few inches to half the branch, as shown in B, to prevent shading of lower branches.

Pruning Hedges

The key to developing a thick formal hedge is to begin pruning when the plants are very young. Continued pruning is required, sometimes several times a year. Whether deciduous or evergreen, the hedge should be pruned so that the base is broader than the top, as illustrated in Figure 5.25. This helps maintain full foliage near the bottom since light can reach the lower portion of the plants.

Pruning for Special Effects

There are a number of special effects that can be created with plants (Figure 5.26). With few exceptions, maintenance of these plants requires a great deal of time and effort.

Bonsai is the art of creating miniature trees or shrubs by dwarfing the plant (Figure 5.27). This process requires great skill in pruning both the roots and upper portions of the plant. Bonsai plants have been known to survive hundreds of years with proper care.

Topiary work is another example of specialty pruning. Pruning of plants into unusual shapes becomes a specialized art form (Figure 5.28). Some European formal gardens contain mazes of formal hedges and animal figures created by careful pruning. Plants with dense foliage such as yew and boxwood are most often used in topiary pruning. Such artwork requires a great deal of constant maintenance.

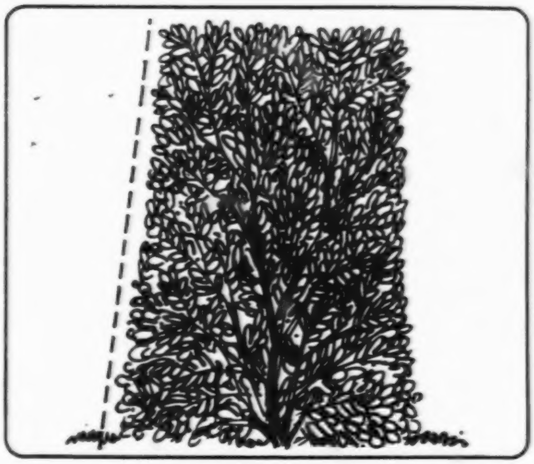


Figure 5.25. Prune a hedge so that the base is broader than the top.

Figure 5.26. Other special effects can be created with living plants.

Espalier is the training of plants to grow in a formal pattern often on the side of a wall, fence or trellis. This training is accomplished by pruning those twigs that grow in any direction other than the one(s) desired. The plant is attached to the flat surface with specially designed clips and formed into the beginning pattern. Frequent, careful pruning is required to train and maintain espalier forms (Figure 5.29).

Figure 5.27. A bonsai plant

Figure 5.28. Topiary makes an excellent visual attraction in a formal garden.

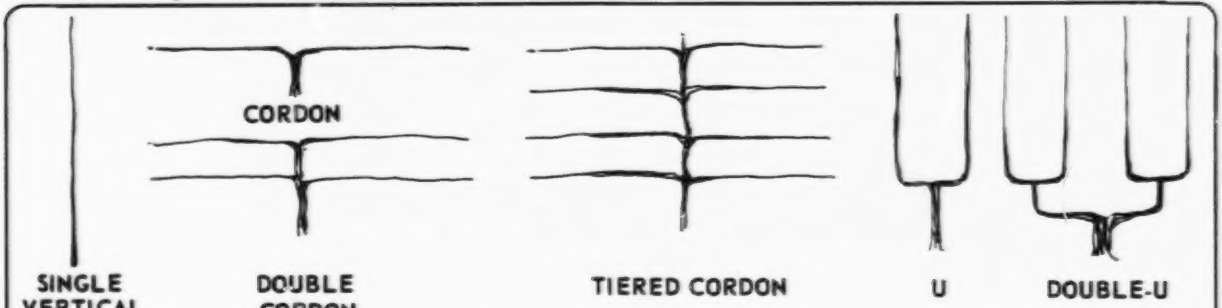

CORDON
SINGLE VERTICAL
DOUBLE CORDON
TIERED CORDON
U
DOUBLE-U
PALMETTE
OBLIQUE PALMETTE
OBLIQUE
BELGIAN FENCE
GOBLET
INFORMAL FAN
FORMAL FAN
MODERN FORMAL

Figure 5.29. Some espalier patterns. The most commonly used is *double-U*.

CHAPTER 6

Climbing and Working in the Tree

Objectives

Certainly the knowledge and experience required for tree work can not be obtained solely from a book. This chapter seeks to provide only the *basic* principles and theories of climbing and working in trees.

1. Know and be able to use the knots and hitches used by a tree climber.
2. Be able to locate and tie into a safe and workable tree crotch.
3. Learn to throw and place a rope in a tree.
4. Be familiar with the various climbing methods.
5. Understand the basics of roping and rigging.
6. Become familiar with the techniques used in aerial rescue.

Planning Ahead

Before climbing a tree, the climber should always look it over. The climber must first know exactly what is to be done in the tree. Inspection of the tree will then yield information such as the location of major limbs that are dead and broken. The location of any electrical conductors or utility lines should also be noted. An experienced tree worker is familiar with different types of trees and knows how strong or brittle their respective woods are. A good climber will plan ahead what route to take in climbing the tree and where to tie in. A little forethought can save a great deal of time and energy later.

Ropes and Knots

Climbing ropes should have a minimum diameter of ½ inch. Most climbing ropes used today are made of synthetic fiber. Synthetic ropes should have an elasticity of not more than 7%. The climber must inspect the climbing rope before use. A rope with any defect at all should not be used. Climbing ropes should never be spliced for repair. If the rope is worn from the safety snap, the snap may be moved to the other end and the worn part of the rope cut off.

The climber must be familiar with all the knots described in Chapter 3. Many of these knots are used routinely while working in the tree. Of course the most important knot to the climber is the tautline hitch (Figure 6.1). It would be most helpful for the climber to be able to tie this knot with one hand or without looking. This may become necessary in the event of an emergency.

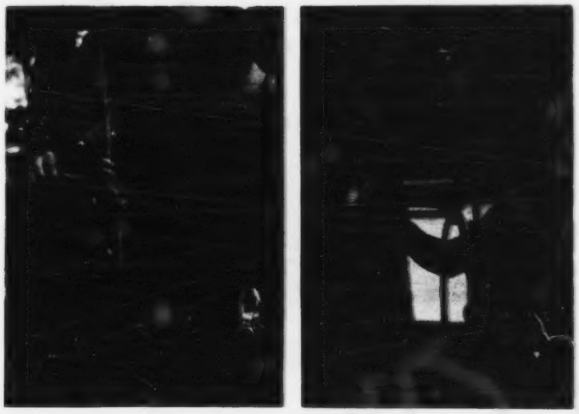


Figure 6.1. The tautline hitch shown from two angles

Choice of Crotch

As mentioned earlier, the choice of where to tie in may be made before climbing the tree. Generally it is desirable to pick a very high central location in the tree. This allows freedom of movement and easy access to any point below in the tree. It is easiest to work when tied in directly above the working area. Never tie into a crotch that would allow swinging into power lines in case of a fall.

The crotch selected for tying in should be wide enough for the rope to pass easily through. The limbs must be large enough to support the climber with no risk of breaking. When tying in, the rope should pass over the lateral and around the main branch (Figure 6.2). Then if the lateral should break, the climber's line will drop to the next crotch and not completely out of the tree.

Rope Throw

Frequently the climber cannot use a ladder to get even to the first branch. The climber must be able to throw the climbing line into the tree in order to begin climbing. On short throws it may be easiest to simply loop the rope over a low limb. For trickier throws the climber may tie a "monkey's fist." A monkey's fist is simply a series of wraps that hold the rope together to facilitate throwing. These wraps can be made to unwind after the rope passes over the limb. Figure 6.3 illustrates the monkey's fist, ready for throwing. Whatever method is used, practice is important to gain accuracy.

At times the climber must throw the rope to get higher within the tree. In such cases skill and accuracy will save a great deal of time. The climber sometimes also has the option of placing the rope higher using a pole pruner. The loop of the monkey's fist is placed over the lever of the pole pruner (**not** over the cutter!). After the pole is positioned over the desired limb, a quick tug of the pole rope will drop the climbing line in place. This too requires a little practice.

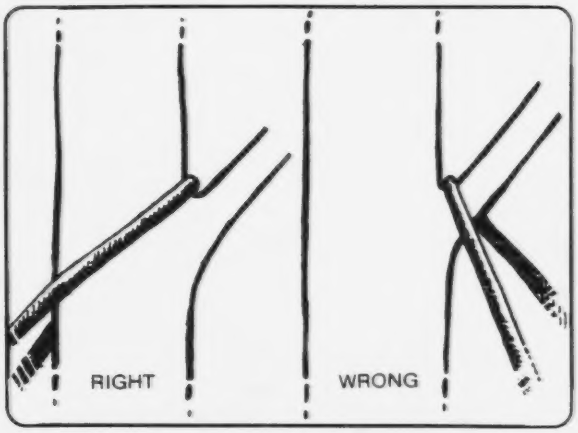


Figure 6.2. The rope should pass around the main leader, not around the secondary branch.

Figure 6.3. A "monkey's fist" all ready to throw

Some climbers choose to set their rope high in the tree with the use of a throwing ball. A throwing ball is a rubber-coated weight in teardrop shape with a very long nylon string attached. The throwing ball can be thrown into a tree with reasonable accuracy up to 60 feet. Figures 6.4 and 6.5 show how the throwing ball is held prior to the toss. After the ball passes through the tree crotch, it comes to the ground. The climber's line is tied to the ball string end (Figure 6.6) and pulled through the crotch. If the crotch is tight or V-shaped, the rope should be tied to the throwing ball string using a long series of half hitches. This will keep the climbing rope from getting caught as it reaches the crotch. Use of the throwing ball can save a climber several rope throws in ascending a tree.

Ascent

There are several ways of ascending the tree. For safety purposes it is best either to be tied in or to use the safety strap at all times when in the tree. Often a climber uses a ladder to get up into the tree. (Note that ladders made of metal or other conductive materials must **never** be used near an electrical conductor.) The ladder should be steadied by another worker on the ground. The climber should not work from the ladder as it is not as safe or predictable as working from a rope.

Another method of reaching the first branch is to shinny up the tree. Since this method requires a great deal of strength and energy, a worker should never shinny a distance greater than 15 feet. A safety strap may be used for added security.

Lumberjacks often climb trees with the aid of spurs. Since climbing spurs cause unsightly gashes in the tree, which in turn may become entryways for insects and disease, spurs should be used only on trees to be removed.

The primary means of ascending a tree is the **body thrust** method (Figure 6.7). With the rope already in the tree, the climber attaches one end to

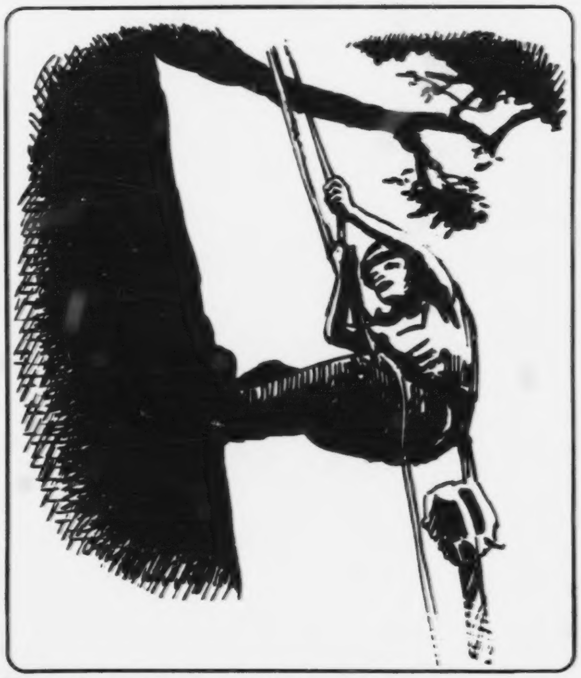


Figure 6.7. The legs and body are just as important as the arms in the body thrust method.

Figure 6.4. Hold the rope and swing the ball to gain momentum.

Figure 6.5. Most tree workers prefer to hold the rope this way.

Figure 6.6. Notice how the climbing rope is tied to the ball rope.

Figure 6.8. The climber grips the rope tightly with his hands.

Figure 6.9. He pulls his feet up under his body.

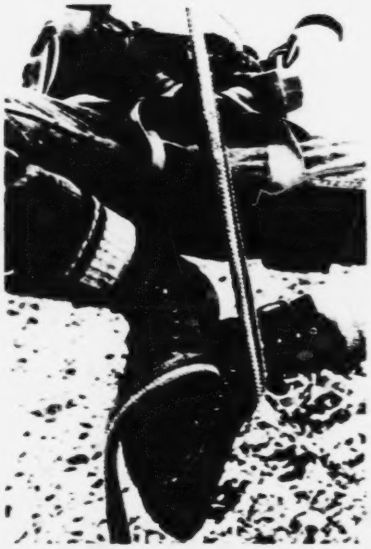


Figure 6.10. Notice how the rope is gripped between the feet.

his/her saddle.The climber may or may not tie the tautline hitch. If the climber chooses not to tie in, another worker must hold the other end of the rope as the climber goes up. The ground worker must not release the rope until the climber is safely tied in.

The secret of the body thrust is to use the entire body and not to rely totally on the arms. The trick is to place the feet high on the tree and pull hard with the arms while thrusting the body upward. When done rapidly and efficiently, the climber appears to be simply walking up the tree. If the climber attempts to pull all the way up with the arms, fatigue will become a serious factor.

Footlocking is a popular method of climbing a rope. The rope must be up in the tree, usually with both ends on the ground. The climber actually climbs both strands of rope together. The climber holds the rope tightly above the head and pulls the feet up underneath. The rope is then gripped tightly between the feet while the climber "stands" and re-grips the rope higher above the head. The series of photographs in Figures 6.8 through 6.11 illustrate the footlocking process. Although footlocking is faster than other methods, some companies prefer that their climbers avoid use of this method since the climber is not actually tied in. A general rule of thumb is to footlock distances no greater than 25 feet. It is also helpful if the rope is over the second branch up, for this allows the climber to land on the lower branch. It is difficult and unsafe to footlock up to the same branch on which the rope is crotched.

Figure 6.11. The climber should be able to hold himself with his feet and have his hands free if necessary.

Once in the tree, the first step is to tie in. The climber's knot or tautline hitch is tied from the tail of one strand of rope to the other strand (Figure 6.12). Figure 6.13 shows the tautline hitch.

If the climber wishes to go higher in the tree to tie in, there are two options. The safety strap can be used while the climber unties and rethrows the climbing rope. Also the climber can use the other end of the climbing rope to tie in higher and then untie the first knot.

In very high trees the climber is best advised to tie a figure 8 knot in the far end of the climbing rope. This will prevent slipping of the end of the

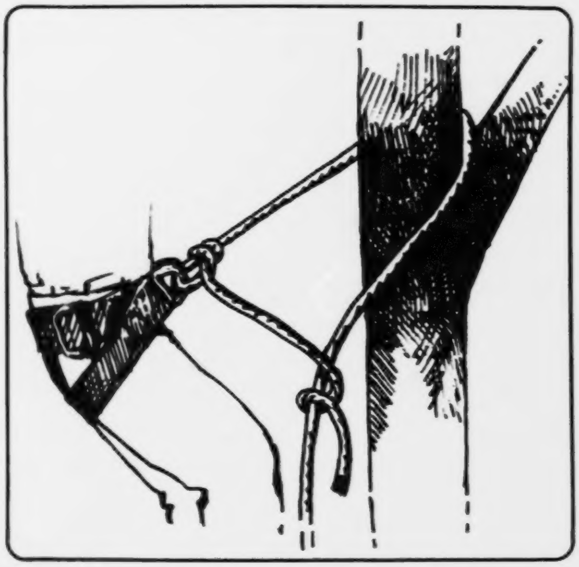


Figure 6.12. Tie the tautline hitch using the tail of the rope coming from the attachment to the saddle.

rope through the tautline hitch as the climber comes down. Some climbers also tie a figure 8 knot in the cross rope between the D-rings of the saddle and the tautline hitch. This is identify where to cut in an emergency. If the climber must be rescued, a ground worker can hold the other end of the climber's rope while a worker cuts the rope at the figure 8 knot with a pole pruner. The climber can then be safely lowered from the ground. Figure 6.14 shows where the figure 8 knot would be tied.

Working in the Tree

In most cases it is best to climb to the top of the tree and tie in before beginning to work. Some climbers prefer to do some work on the way up, however. Dead limbs may be broken off to reduce risk in climbing. In very dense trees it is sometimes helpful, while ascending, to remove some inside limbs to facilitate dropping other limbs through from high in the tree. A climber should **never** work in a tree without being tied in safely.

Whenever a limb is going to be cut or a tool dropped to the ground, an audible warning should be sounded for the workers below. Some commonly used warning calls include "Headache!," "Heads up!" and "Timber!"

While working in the tree, the climber has one "most valuable" tool — the climbing rope. One important function of the rope is to catch the climber in the event of a fall. The rope can also be used to help the climber maintain balance and maneuver throughout the tree. For example, when walking far out on a horizontal limb, the climber can walk out backwards keeping tension on the climbing line. This enables the climber to remain steady on the limb. The climbing rope keeps the climber safe in the tree while freeing the hands for other work (Figure 6.15). It takes time and

Figure 6.13. Always check the tautline hitch after tying in.

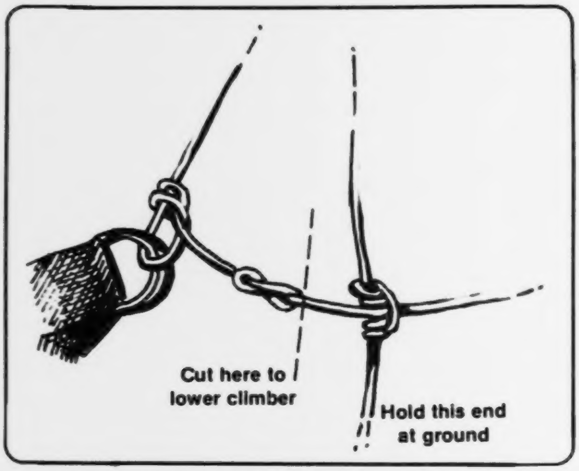


Figure 6.14. A figure 8 knot and where to cut the rope in an emergency

Figure 6.15. Using the climbing line allows the climber's hands to be free to work.

experience before a beginning climber gains enough confidence to rely completely on the climbing rope.

Crotching the rope high in a central location within the tree allows great mobility. Usually the climber can reach most points without re-crotching. If a slip were to occur, the climber would swing back toward the center of the tree (though not necessarily so in a wide-spreading tree). Branches often grow a great distance from the center of the tree and are more difficult to reach. Also, if the climber goes too far out on the rope and falls, he or she may reach the ground before the rope pulls taut and stops the fall. So when working far out from the center of the tree, the climber may choose to "double crotch." Double crotching is simply tying in on a second limb with the other end of the climbing line without untying the first tautline hitch (Figure 6.16). This affords the climber extra safety and makes it easier to work distant portions of the tree.

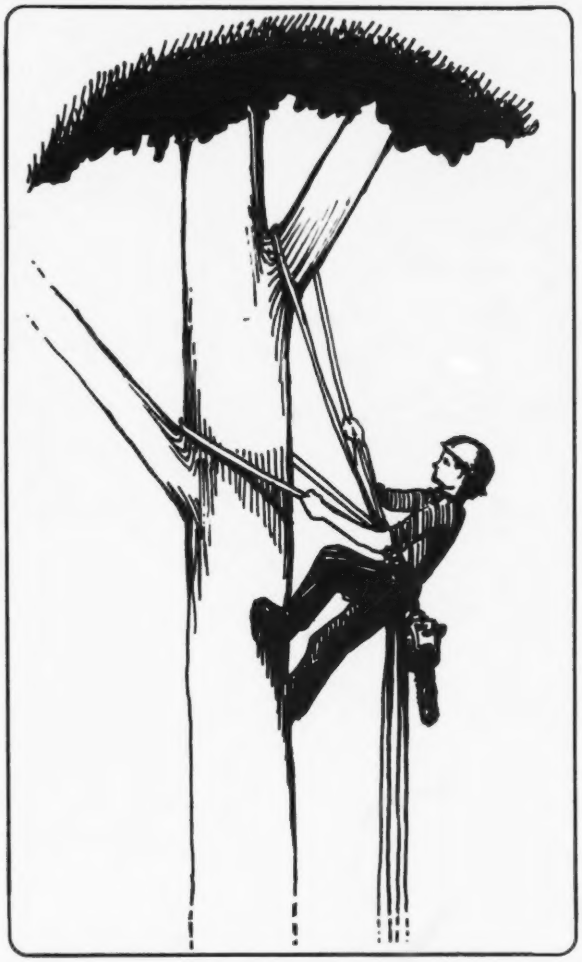


Figure 6.16. Example of double crotching

1) Take far end of climbing rope through second crotch.
2) Tie bowline at D-rings of saddle, leaving about 4' tail.
3) Tie tautline hitch with tail to other strand of rope.

There are several disadvantages to double crotching. Freedom of movement can be greatly reduced. Working with two knots simultaneously can become difficult. Also, the remaining portion of the rope may not reach the ground, so that it is difficult for ground workers to send up tools. Of course it is usually wise to untie one tautline hitch before attempting to come down from the tree.

Electrical Hazards

Working in proximity to electrical lines and other equipment can be extremely dangerous. Direct or indirect contact with any energized cables or conductors can be fatal. Such contact can be made through tools, tree limbs and equipment. Electrical shock will occur if the tree worker provides a path for electrical current to flow to a grounded object. Simultaneous contact with two conductors is almost certain to result in serious injury or death.

Before climbing or working around any tree, a close inspection should be made by the tree worker and the supervisor to locate any electrical conductors. Only trained and qualified line clearance workers should work around electrical conductors. Such training is available through the National Arborists Association and many private companies. A second qualified line clearance worker should be present at all times. This manual in no way prepares or qualifies any tree worker for working around electrical conductors. Table 6.1 gives the minimum working distances from energized conductors for line clearance tree trimmers, as established by the 2133 committee for the American National Standards Institute.

Table 6.1. Minimum working distances from energized conductors for line clearance tree trimmers.

VOLTAGE RANGE (phase to phase) kV	MINIMUM WORKING DISTANCE
2.1 to 15.0	2 ft. 0 in. (0.6m)
15.1 to 35.0	2 ft. 4 in. (0.7m)
35.1 to 46.0	2 ft. 6 in. (0.75m)
46.1 to 72.5	3 ft. 0 in. (0.9m)
72.6 to 121.0	3 ft. 4 in. (1.0m)
138.0 to 145.0	3 ft. 6 in. (1.05m)
161.0 to 169.0	3 ft. 8 in. (1.1m)
230.0 to 242.0	5 ft. 0 in. (1.5m)
345.0 to 362.0	7 ft. 0 in. (2.1m)
500.0 to 552.0	11 ft. 0 in. (3.35m)
700.0 to 765.0	15 ft. 0 in. (4.55m)

ANSI 2133.1-1982

Adapted from *American National Standard for Tree Care Operations,* American National Standards Institute, 1430 Broadway, New York, NY 10018

Workers who are not trained and qualified in line clearance tree trimming should not work in close proximity to electrical conductors. A minimum of 10 feet clearance should be maintained for energized conductors rated 50kV phase-to-phase or less. A 15- to 20-foot clearance should be maintained for conductors rated more than 50kV. **Caution:** Coated wires, rubber boots and rubber gloves should **not** be considered safe as insulation from electrical hazards. Tools and equipment made of non-conductive materials can conduct electricity when dirty or wet.

Rigging

When pruning or removing trees in an urban or residential area, tree workers must contend with wires, buildings, expensive landscapes and traffic. Rarely can a climber just "cut it and let it drop." To avoid the many environmental obstacles and maximize safety, tree workers use ropes to lower limbs slowly.

Rigging is as much an art as it is a science. It requires skill, finesse and experience. Although there are many ways to go wrong in rigging, there is no single *right* way. Each company and each climber has his or her own unique way, but the basic principles are the same.

There are a few important rules to remember, no matter how simple the rigging job is. First, always use adequate equipment for the job. Ropes should be long enough and strong enough. Remember that knots and hitches greatly decrease the strength of the rope. Second, always think ahead. It is tough enough to engineer the rigging, but also give serious thought to what might happen if something goes wrong. Finally, make safety the top priority in every operation.

The simplest form of rigging entails tying a rope on the limb to be cut, passing the rope through a crotch above that is strong enough to support the limb, and wrapping the rope around the tree at the base to provide tension (Figure 6.17). The number of wraps around the trunk depends upon the weight of the limb. One worker should be able to hold the rope and lower the limb. Always try to be tied in to a crotch lower than the crotch used for lowering the limb.

Naturally, unless the crotch used for lowering the limb is directly above, the limb will tend to swing. The direction of swing can be predicted. In fact the swing may be used to advantage in order to swing the limb away from or over obstacles such as houses. The climber must know exactly what the limb will do when it is cut. Rope placement on the limb is important to the weight distribution of the branch after the cut. The climber can control whether the limb will be top or butt heavy. Many inexperienced tree workers have been pinned or knocked out when a limb has come back on them. It is safest to make the cut from above the limb. Always plan an escape route. If using a chain saw, shut it off immediately after the cut has been made.

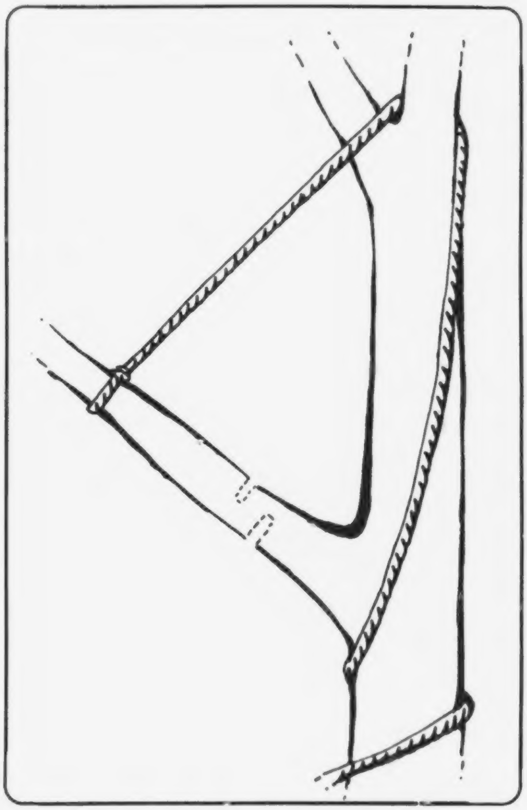


Figure 6.17. Simple diagram of roping down a limb

There can be problems with using other crotches in the tree for lowering limbs. Sometimes there isn't a crotch strong enough or in a good location for the climber's needs. Nylon ropes passing quickly through crotches can damage the tree and the rope. Some arborists use extra equipment for rigging that eliminates the use of tree crotches. A "false crotch" can be created with the use of a snatch block tied or strapped in the tree. The lowering rope passes freely over the pulley. A side-opening block can save time when using the false crotch to lower many limbs in succession. The rope need not be threaded through each time. Figure 6.18 shows some equipment that might be used in rigging.

In addition to what can be done with ropes, the climber can influence the speed and direction of the limb's fall by the way the cut is made. A notch may be cut at various angles on the limb to make the limb go in a desired direction (Figure 6.19). Also, ropes tied on the far end of the limb may be

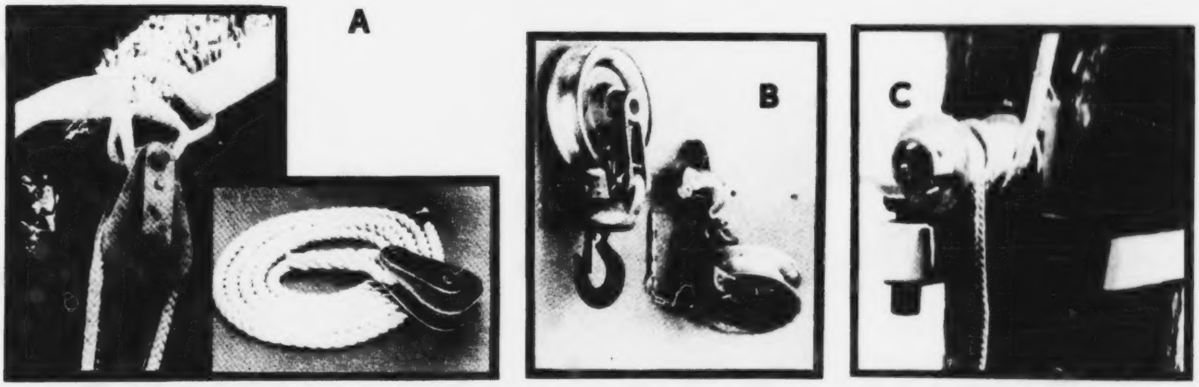


Figure 6.18. Equipment used in rigging
- **A)** Apparatus that can be used to create a "false crotch."
- **B)** Snatch blocks that save time and effort in lowering large limbs.
- **C)** A lowering device that eliminates need for rope wraps around the tree trunk; saves time and manpower.

used by ground workers to pull the limb over. Before tying off the limb, the climber must decide whether the limb is to go down brush first or butt first. Experience will tell the climber how far out to tie the rope. Sometimes the climber may intentionally peel the cut (fail to make an undercut) to allow the limb to drop slowly.

The choice of knots to use when tying off a limb is largely a matter of personal preference. Two of the best knots for this are the clove hitch and the running bowline. Both tighten up as tension is applied; this helps keep the rope from slipping. The clove hitch does not decrease the strength of the rope as much as the running bowline. The running bowline is very easy to untie even after a great deal of weight has tightened the knot. If a clove hitch is used, a half hitch or bowline should be used in combination for added security.

The most exciting thing about rigging is that every situation is different. With added experience, the climber can learn new tricks. Yet each limb presents a new set of circumstances. For a climber "piecing out" his or her first large, difficult tree, the experience is similar to a pilot earning his or her wings.

Aerial Rescue

A tree worker must take many precautions to guard against accidents. But it takes only one lax moment or an unexpected event for an accident to happen. Because of this, every worker on the crew should be trained in first aid, CPR (cardiopulmonary resuscitation), and aerial rescue. Aerial rescue is the process of bringing an injured or unconscious worker down from the tree.

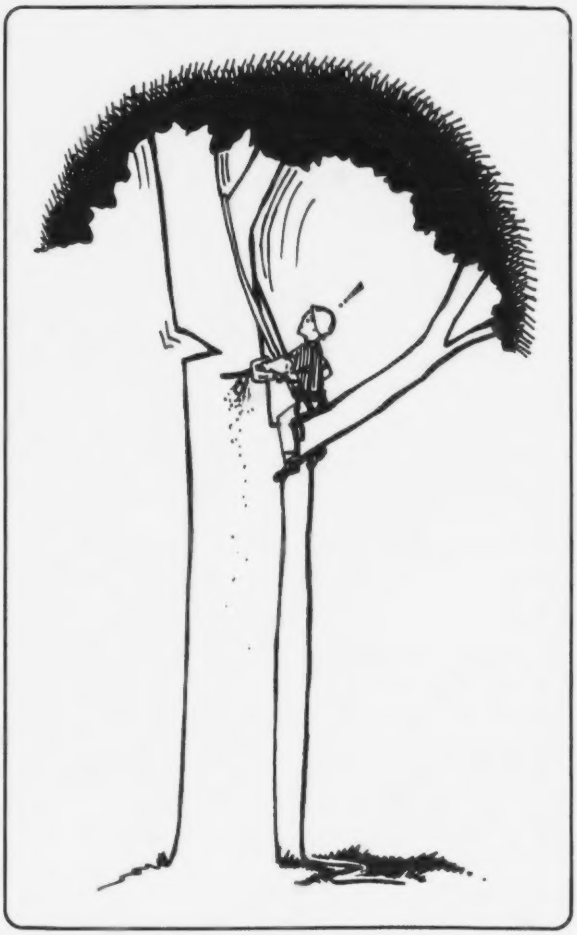


Figure 6.19. Think ahead!

The two most important aspects of aerial rescue are speed and safety. If the victim is not breathing or is bleeding severely, there may be only minutes before death. There is no time for panic. Yet a rescuer that fails to take the proper precautions may become a second victim.

There are a number of ways a climber can be injured in the tree. Electrocution, heart attack, heat prostration, a blow to the head, or a severe chain saw cut could leave a worker dangling helplessly in the tree. Ground workers should maintain a close watch on climbers. A climber may get hurt and lose consciousness without ever calling for help.

When a climber is injured or unconscious in the tree, the rescue procedure should begin immediately. If there is more than one worker in the area, one should go and call for emergency help at once. If there is only one rescuer, he or she may shout for assistance but must stay and help the injured climber.

The first step is to determine whether there is an electrical hazard. If there is, contact must be broken immediately between the wires and the victim or wires and the tree. This can be done by either pulling the wires away or the victim away with a clean, dry rope or other non-conductor. Never attempt to climb a tree that may be energized. If necessary, a rescuer could footlock up a rope without touching the tree.

Once any risk of electrocution has been eliminated, the next step is to get to the victim as fast as possible. The rescuer should wear a climbing saddle with a safety strap. Spurs may be used to get to the victim quickly, or the rescuer may climb the victim's rope if it has not been damaged. Upon reaching the victim, the rescuer must either tie into the tree or clip into the victim's D-rings using the safety rope or strap. The rescuer should keep the victim across his or her legs and support the head (Figure 6.20).

A quick check should be made to determine the condition of the victim. If there is serious bleeding, steps should be taken to stop it at once. Elevate the wound if possible and apply direct pressure (with a clean cloth if practical). If there is severe bleeding from the head, do not apply pressure. If the victim is not breathing, use artificial respiration, clearing the airway, pinching the nose, and giving several quick breaths through the mouth. CPR can not be applied in the tree.

Figure 6.20. After clipping in, cradle the victim in your lap while supporting the head.

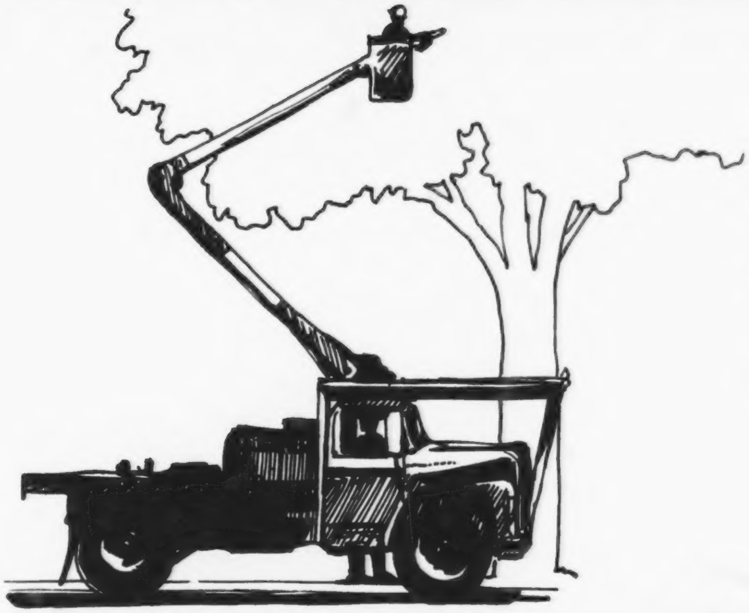
If the victim appears to have a broken neck or spinal injury, no attempt should be made to lower him or her. The best thing to do is make sure the victim is safely tied in, and get emergency help. If the victim is not breathing or is bleeding severely, take the necessary steps described previously while jostling the victim as little as possible.

Before lowering the victim, be sure that both rescuer and victim are safely tied in. Check the victim's rope for damage. If it appears safe, both rescuer and victim can come down on the victim's rope. Do not try to come down too fast, or further injury may result. If practical, a ground worker can lower the injured person with the climbing line.

Once the victim has been lowered safely to the ground, the climbing saddle should be removed. If emergency help has not yet arrived, take further first aid steps. Begin CPR immediately if there is no breathing or no pulse (Figure 6.21).

It is not possible to foresee when or where accidents will occur; they usually occur when least expected. The ability to react swiftly and safely to save a life depends on keeping a cool head, using common sense, and being prepared. Proper training and practice can save a few crucial minutes that may mean the difference between life and death.

Figure 6.21. CPR cannot be done in the tree, but should begin immediately once on the ground, if necessary.



CHAPTER 7

Aerial Lifts

Objectives

Aerial lifts require special training for all workers. This chapter is intended to acquaint the reader with some of the basic practices involved in aerial lift operation.

1. Become familiar with the steps to be taken before operating the lift truck.
2. Know the basic safety rules for working in or near a bucket truck.
3. Understand the potential hazards of working around electrical conductors.

Aerial Lift Truck

The aerial lift truck or "bucket truck" is designed to raise the tree worker into the tree where work can be done without climbing (Figure 7.1). The designs of aerial lift trucks vary considerably. There may be one, two or three booms which can be operated independently. The worker stands in the "bucket" and can move the booms up and around.

Bucket trucks are used mostly for line clearance work. From a bucket trees can easily be topped below the lines. The bucket and upper boom are both insulated for working around power lines. This helps reduce the electrical hazards line clearance. Lift trucks are not limited to line work. They can also be used for other trimming jobs and tree removal. The biggest limitation of bucket trucks is the inability to access all areas. The booms cannot always be maneuvered into a tree. Also the equipment usually cannot be taken behind houses for backyard jobs.

Daily Inspections

Before starting out for the day, inspect the aerial lift truck (Figure 7.2). This inspection is primarily a visual check of the unit. Trouble can be avoided later in the day if problems are found and corrected before leaving the garage.

The insulation on the boom and bucket should be checked for worn or cracked areas that could

Figure 7.1. A lift truck is valuable in line clearance work.

Figure 7.2. With everything in working order, the lift truck is ready to start the day.

Figure 7.3. The booms and outriggers can be controlled from the ground.

reduce the dielectric integrity of the unit. The boom cables should not have excessive slack. There should be no oil puddles under the truck. If there are, and the oil traces back to the hydraulic system, the source must be located.

When checking for hydraulic leaks, make a visual inspection only. Never attempt to locate or stop a hydraulic leak with any part of the body. Hydraulic fluid in a wound will cause a large infection that can lead to amputation. If hydraulic fluid reaches the circulatory system, death can result.

Check fluid levels including engine oil, lubricant and hydraulic oil, and add as necessary. Check each control and watch for pressure drops. Check the power take-off (PTO). Be sure the boom is seated in the boom cradle before starting out.

At the Job Site

Once at the job site the tree service workers must control traffic if working near or along the roadway. Traffic pylons (cones) should be set out to divert traffic around the working area. "MEN WORKING IN TREES" signs can be used to alert traffic to overhead dangers. If the boom is to be across the road, a worker should stand by to warn trucks.

The truck should be positioned so as to afford the greatest mobility and access to the trees to be worked on. Careless positioning can waste time and energy and usually results in a poorer trimming job. Utility lines are often the biggest obstacle in positioning the truck.

The outriggers must be down before the booms are raised. These help stabilize the unit. Both can be controlled from the ground (Figure 7.3). When the work area is covered with ice, it should be chipped away and cleared where the outriggers sit. If parked on an incline, the wheels of the truck should be chocked. When working on soft asphalt, workers should place large beams under the outriggers to distribute the weight.

Working from the Bucket

All buckets should be equipped with a safety belt. Using a safety belt keeps the worker from falling out of the bucket in case of equipment failure or a sudden jolt. Unless specifically intended, the bucket should carry no more than one worker. Also, under no circumstances should weight limits be exceeded. The bucket should not be used to lift or lower heavy objects.

The aerial lift operator should always look in the direction of movement. With experience the operator should be able to use the control levers automatically without looking or stopping to think which lever controls what. Care should be taken to avoid hitting any objects with the bucket or booms (Figure 7.4). The bucket should never land on anything as the insulation may be damaged. Although the bucket is insulated, the worker must still avoid contact with phase-to-phase wires or otherwise grounded electrical paths (Figure 7.5).

Many aerial lift trucks are equipped with either hydraulic or pneumatic (compressed air) outlets for tools. Special loppers and saws can be fitted and operated from these outlets. Only one tool should be connected at a time. Tools should be disconnected when not in use or when being serviced. If used correctly, these tools can save time and energy. Once the proper tool is chosen for the pruning cut, the worker should take care to make clean, well-placed cuts. Too often poor cuts are the result of careless workers not taking the time to get into a good position before cutting.

Electric saws or other electric equipment like drills or lights should never be used from the bucket. Such tools can bypass the insulating capacity of the unit.

If the truck must be moved, the booms should be brought to rest in the cradle position. The outriggers must be lifted. Workers should not ride in the bucket when the truck is in motion.

Figure 7.4. Proper positioning of the booms is critical when removing large limbs.

Electrical Hazards

When the lift is in contact with electrical conductors, the truck must be considered energized (Figure 7.6). Anyone standing on the ground and touching the truck simultaneously can be electrocuted (Figure 7.7). The ground around the outriggers may also be charged, especially if it is wet. Any worker in or on the truck should remain there until contact is broken.

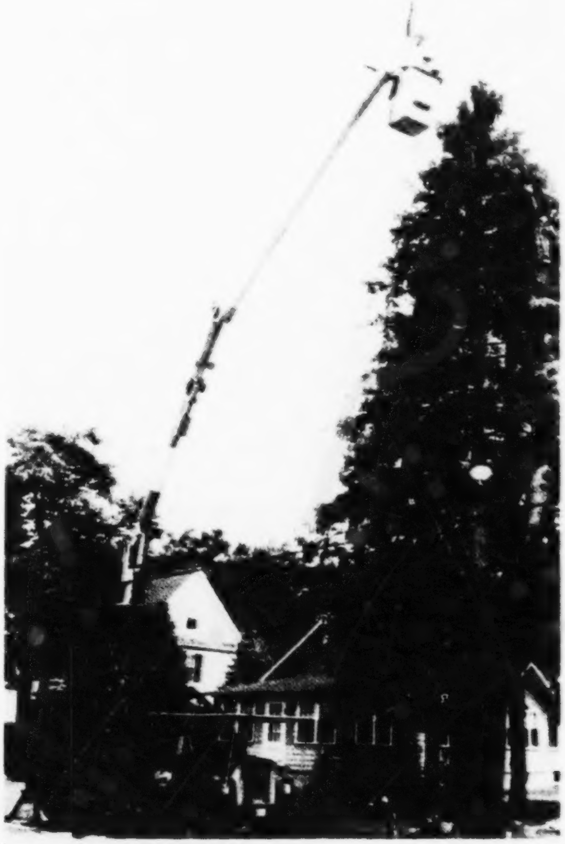


Figure 7.5. This lift truck allows the operator to cut limbs 70 feet above the ground.

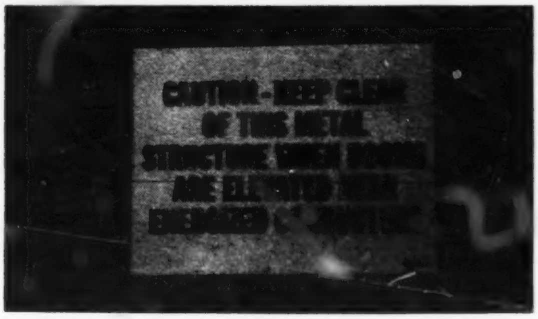


Figure 7.6. *Caution* sign on truck.

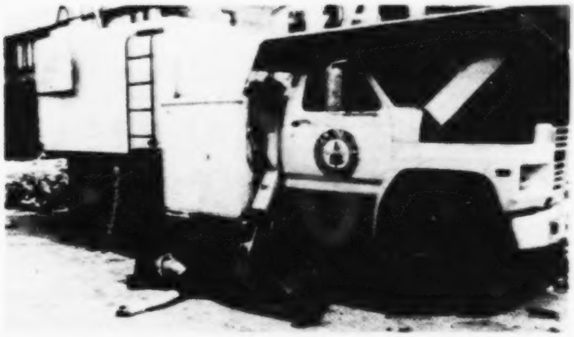


Figure 7.7. The truck will be energized if the lift is in contact with wires. Do not go near it.

If the bucket operator is in trouble, the booms can be lowered from below. If the truck is energized, a worker will not be able to operate the controls from the ground. In case of an emergency, a worker could leap from the ground onto the truck, keeping in mind that the ground near the truck may be energized. Since simultaneous contact with both truck and ground may be fatal, this leap should not be attempted unless it is absolutely necessary.

If necessary the lift system can be bypassed. Workers should be instructed how to lower the booms by releasing the pressure in the lift system. The boom can then be pulled down manually using ropes.

All tree workers who use aerial lifts should have special training. Operation, maintenance and safety considerations of aerial lifts require extra instruction. Since this equipment is frequently used near electrical hazards, special attention must be given to training in electrical dangers and emergency procedures.

CHAPTER 8

Tree Identification

Objectives

The purpose of this chapter is to introduce the student to some of the plant features used to identify trees. Selected common trees are included with drawings and descriptions.

1. Learn to look at plants both close up and at a distance when trying to identify them.
2. Become familiar with seasonal characteristics of trees that may help in identification.
3. Learn to use every tool available for identification including the senses of touch and smell.

Accurate identification of trees requires a combination of knowledge and experience. It is important to learn a number of plant characteristics that are used to distinguish one tree from another. Size, habit, texture and color all help to identify plants. Practice and repeated exposure help one become proficient at identification.

Many trees can be identified from a distance by their form and habit. For example, the American elm, with its vase-shaped form and over-arching limbs, is hard to mistake for other species. An upright or conical form might be an identifying feature of certain other trees. The upper branches of pin oak are upright, while the lower branches droop to the ground, giving it a rather unique form, easy to identify. Some trees, like flowering dogwood, have a horizontal branching habit. This gives the tree a delicate, layered appearance.

Another identification tool is the bark of the tree. Bark varies a lot among tree species. White birch is famous for its white peeling bark (Figure 8.1). Sycamores are also known for their peeling bark, gray in color, which exposes a very light inner bark (Figure 8.2). Ash trees have a uniformly furrowed bark, while the furrows on cottonwood are deep and corky. American beech has a smooth, shiny gray bark. Sometimes in the forest, the bark is the only part of the tree that can be seen. Knowledge of bark characteristics can be very useful to a tree service worker as well as to a forester.

The smaller branches and twigs can also be useful in tree identification. Some twigs have "wings" or ridges. Others have characteristic thorns or spurs (Figure 8.3). The lenticels that dot the surface of twigs can be very characteristic of certain plants. Even the type and color of the pith in the center of the twigs can help to identify trees.

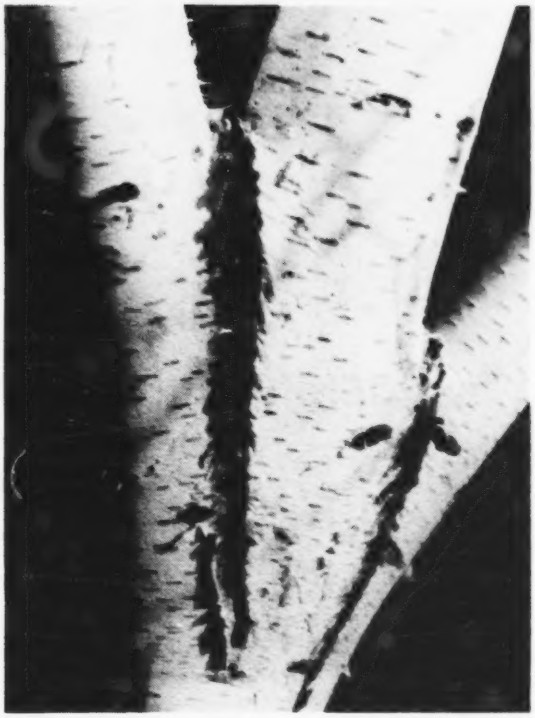


Figure 8.1. The bark of the European white birch is easily identifiable.

The buds, though relatively small, may be the single most important identification tool, as they are available year-round even when leaves are not present. Students can learn to identify many different tree species by learning dormant bud characteristics. Buds can be scaled or valvate, opposite or alternate, single or clustered. They come in various colors and sizes. As buds swell and break in the spring, however, they are difficult to use in identification.

Foliage is the part of the tree most commonly used in identification. Leaves are very characteristic in shape, color, texture, and arrangement. The lobes, margins and general morphology (shape) can be described in detail to help identify plants. Fall color can also be useful in identifying trees from a distance.

Other parts of the tree are also used in identification. Flowers, though present for a short time, are often very helpful in identifying species. The different characteristics of fruits, nuts and seeds are also used. Cones are important in identifying conifers.

Sometimes tree identification can be confirmed using other senses besides sight. Certain trees have characteristic odors to their twigs, leaves, flowers or fruit. The texture of leaves can be felt between the fingers. Some people can even distinguish the characteristic sound of a snapping twig. Of course taste can be characteristic in edible plant parts, but making taste tests is not recommended for identification.

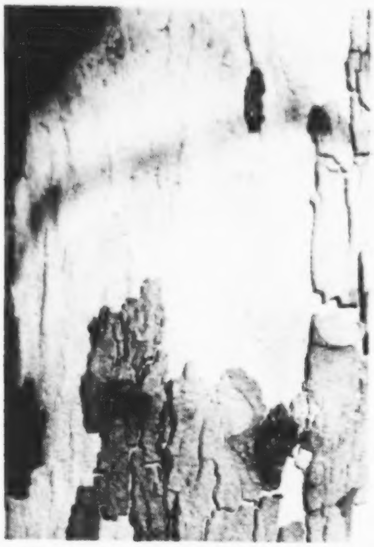


Figure 8.2. The bark of the London planetree flakes off exposing the buff-colored new bark.

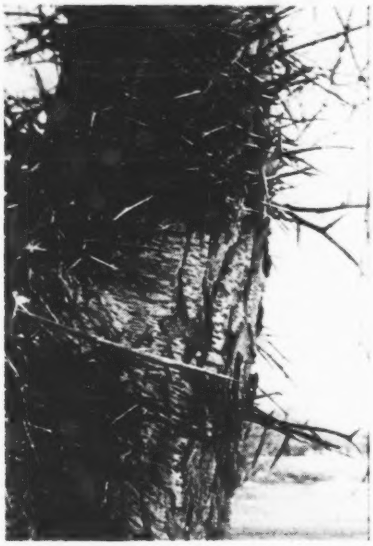


Figure 8.3. Native honeylocust with thorns that grow up to one foot in length

Plant Nomenclature

Scientific nomenclature (naming) is based on taxonomy. Taxonomy is the system of classification of all living organisms. The first classification level, **kingdom**, divides plants from animals. The following list shows how each level of classification is subdivided. *Sugar maple* is used as an example.

CLASSIFICATION SYSTEM

Kingdom	Plantae
Phylum (Division)	Spermatophyta
Subdivision	Angiospermae
Class	Dicotyledoneae
Order	Sapindales
Family	Aceraceae
Genus	**Acer**
Species	**saccharum**

Using common names of trees can be confusing since names vary from region to region. However, every plant has a scientific name (in Latin) that is the same throughout the world. Using the scientific name eliminates the confusion in plant names.

The scientific name of an organism has two parts. The first, which is capitalized, is the **genus**. Plants in the same genus are closely related and show similar characteristics. Maples, for example, are all in the genus *Acer*. The second part, the specific epithet, identifies the **species** and is not capitalized. The scientific name of sugar maple, for example, is *Acer saccharum*.

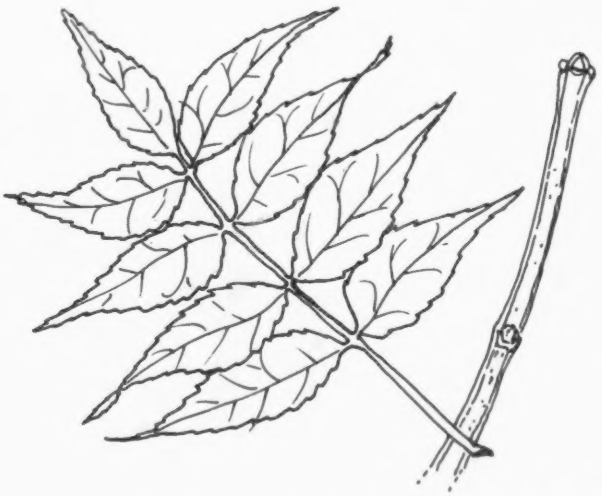
Some species are further divided into genetically unique plants or clones. There may be varieties or cultivars of some plants. Variety names are added to species names and are not capitalized, e.g., *Gleditsia triacanthos inermis*, the complete name for thornless honeylocust. They may be preceded by the abbreviation **var.** Cultivar names are capitalized and enclosed in single quotation marks; for example, *Acer rubrum* 'Red Sunset' is Red Sunset red maple.

Descriptions of some of the more common North American trees have been included in this manual. In the next few pages they are discussed in alphabetical order by common name, since readers may not be familiar with scientific nomenclature.

A final note about choosing appropriate trees for the landscape. It is important to consider all the characteristics of a plant before planting. Size, hardiness, messy fruit — all might be limitations of certain plants in certain sites. Also check for the plant's sensitivity to salt, pollution, diseases and pests. Notes on limitations and outstanding characteristics are included in each of the following plant descriptions.

DESCRIPTIONS OF SOME COMMON NORTH AMERICAN TREES

ASH



BLUE ASH - *Fraxinus quadrangulata*

Leaves: opposite, pinnately compound with 5-11 leaflets, dull green in summer, yellow in fall

Stem: yellow-brown, stout, four-sided with corky winged ridges

Buds: tan, pubescent

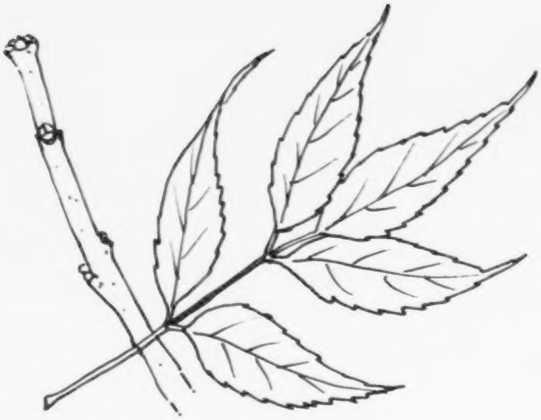
Size and form: 50-75 feet at maturity; irregular habit

Flowers: panicles appearing with the leaves in spring; not ornamentally important.

Fruit: tan-colored samaras ripening in midsummer, persisting through winter

Comments: tolerant of dry alkaline soils

GREEN ASH - *Fraxinus pennsylvanica*



Leaves: opposite, pinnately compound with 5-9 leaflets; dark green and pubescent underneath

Stem: twig pale brown and stout with conspicuous lenticels; large leaf scars

Buds: dark brown, set above leaf scar

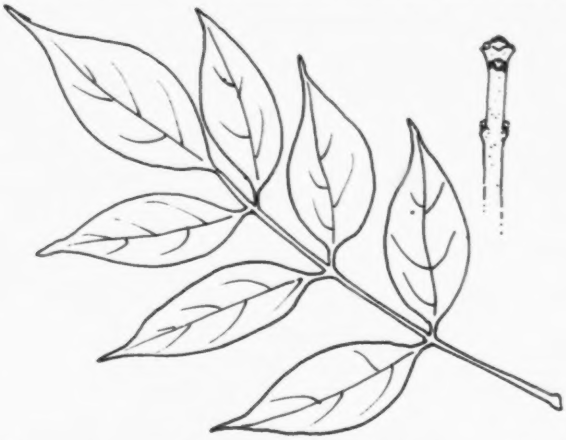
Size and form: 50-70 feet with upright, spreading habit

Flowers: dioecious, purple panicles, blooming before the leaves emerge

Fruit: tan samaras ripening in late summer, persisting

Comments: very adaptable in difficult urban areas; borers a problem; 'Marshall's Seedless' - male, attractive yellow fall color

WHITE ASH - *Fraxinus americana*



Leaves: opposite, pinnately compound with 5-9 leaflets; rich green in spring and summer, golden to purple in fall

Stem: stout, grayish, with U-shaped leaf scars

Buds: dark brown, inset in leaf scar

Size and form: 60-100 feet; open, ovoid habit

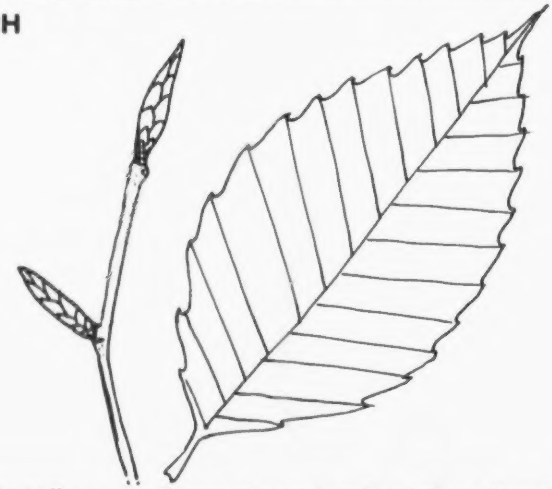
Flowers: dioecious, panicles, not ornamentally important

Fruit: tan samaras ripening in midsummer, persisting

Comments: aesthetically excellent when healthy; borers can cause problems; many insect and disease problems on stressed trees.

BEECH

AMERICAN BEECH - *Fagus grandifolia*



Leaves: alternate, dark glossy green; when dry, persisting through winter

Stem: slender gray twigs with zigzag habit

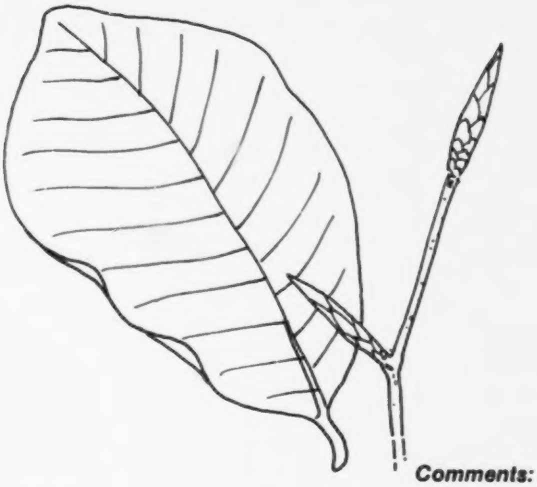
Buds: brown, long, slender and pointed

Size and form: 60-90 feet; dense with wide spread

Flowers: male and female separate on same tree; blooms after leaves emerge

Fruit: nut in prickly husk, ½-1 inch; ripening in fall

Comments: large native tree with some pests; sensitive to soil compaction and construction injury; beech scale can be problem



EUROPEAN BEECH - *Fagus sylvatica*

Leaves: alternate, dark and glossy with wavy margin

Stem: olive-brown twigs

Buds: long, slender, brown

Size and form: 50-60 feet, upright, irregular habit; branches growing down trunk to the ground

Flowers: monoecious; blooming after leaves emerge; ornamentally unimportant

Fruit: nut in husk; ripening in fall

Comments: an excellent specimen tree; lovely cultivars available

BIRCH

EUROPEAN WHITE BIRCH - *Betula pendula*

Leaves: alternate, dark glossy green, double serrate and pointed; yellow-green in fall

Stem: twigs thin and smooth, brown to gray

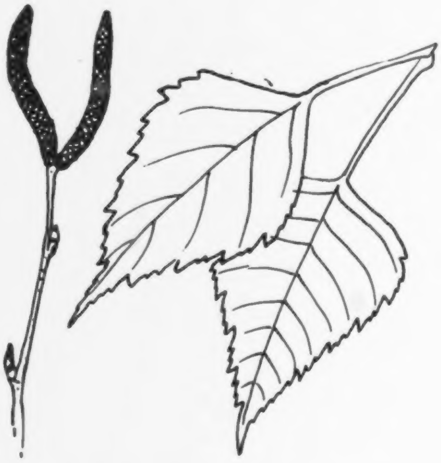
Buds: brownish, curved, with striped appearance

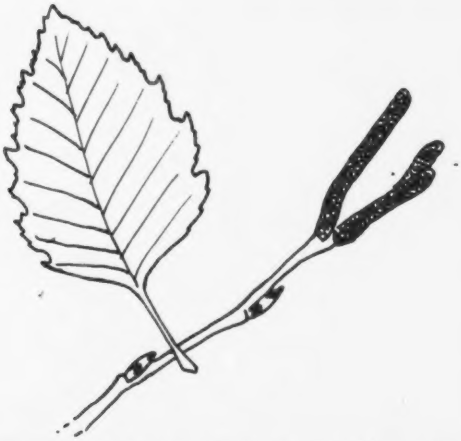
Size and form: 50-75 feet; pyramidal habit opening up with age; pendulous branches

Flowers: long catkins

Fruit: tiny nutlets

Comments: bronze birch borer can be a serious pest; also leaf miner and chlorosis in some areas





RIVER BIRCH - *Betula nigra*

Leaves: alternate, double serrate, glossy green and whitish beneath; golden yellow in fall

Stem: red-brown, slender twigs, conspicuous lenticels

Buds: light brown, stalked and very small

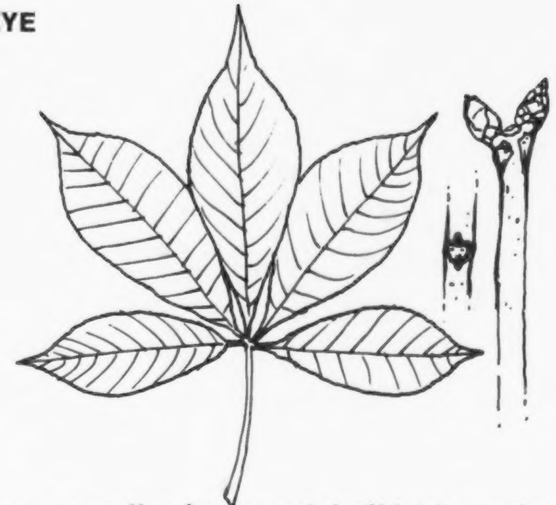
Size and form: 50-75 feet, pyramidal in youth, rounded at maturity

Flowers: monoecious catkins 2-3 inches long

Fruit: small nutlet

Comments: quite city-tolerant; attractive, cinnamon-colored, peeling bark; chlorosis in high pH soils

BUCKEYE



OHIO BUCKEYE - *Aesculus glabra*

Leaves: opposite, palmately compound with five leaflets; orange-red in fall

Stem: stout, light brown; disagreeable odor when damaged

Buds: large, papery, brown, ½-¾ inch long

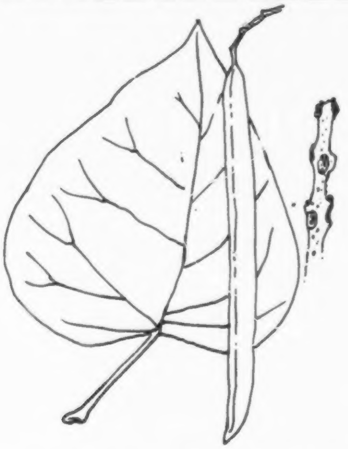
Size and form: 30-50 feet; rounded form

Flowers: perfect; upright panicles, yellow-white; blooming in mid-May

Fruit: glossy nut enclosed in prickly husk; poisonous

Comments: grows well in more natural areas, not in urban areas; suffers from scorch, leaf blotch, powdery mildew

CATALPA



NORTHERN CATALPA - *Catalpa speciosa*

Leaves: opposite to whorled, large, heart-shaped, smooth above, pubescent below; yellow-green in summer, yellowish in fall

Stem: stout, yellow-brown; large leaf scars

Buds: small and brown; terminal bud absent

Size and form: 75-100 feet; open and irregular crown

Flowers: large, white clusters blooming in June; monoecious

Fruit: brown cigar-like capsule 10-20 inches long

Comments: coarse-textured tree with few problems; somewhat messy, not very well suited to urban areas

CHERRY

BLACK CHERRY - *Prunus serotina*

Leaves: alternate, glabrous, dark green; yellow to orange in fall

Stem: slender, red-brown twigs

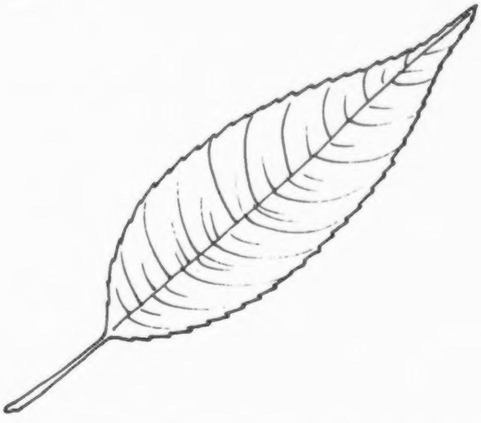
Buds: ⅛ inch, red-brown

Size and form: 50-60 feet; ovoid habit

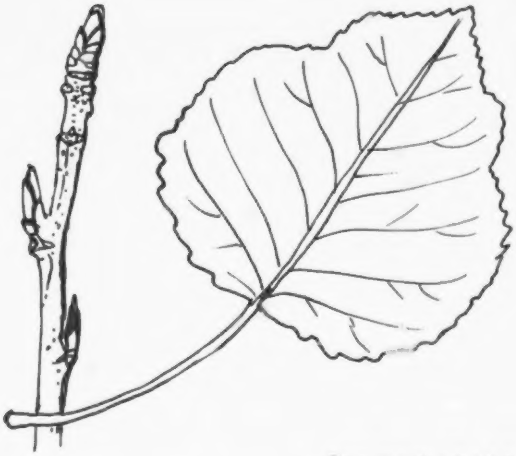
Flowers: white racemes 4-6 inches long, pendulous, blooming in May

Fruit: ¼-½ inch drupe, red, turning black

Comments: high value of fruit for wildlife and for use in jelly-making; pests - fall webworm and borers; interesting platy bark



COTTONWOOD



EASTERN COTTONWOOD - *Populus deltoides*

Leaves: 3-5 inches, alternate, deltoid-ovate, with curved teeth; bright green in summer, yellow in fall

Stem: stout, gray to yellowish

Buds: large, ¾ inch long, yellow-brown and pointed, resinous

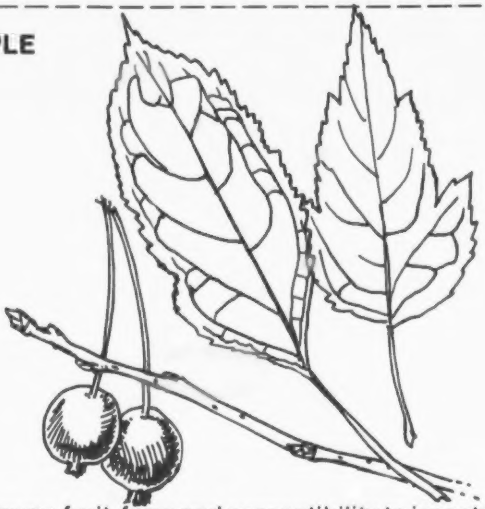
Size and form: 75-100 feet; pyramidal in youth, opening with age

Flowers: dioecious, pendulous catkins 3 inches long

Fruit: clustered, drooping capsules which split to release cottony seeds

Comments: a very messy, weak-wooded tree; tolerant of harsh conditions

CRABAPPLE



CRABAPPLE - *Malus* spp.

Leaves: simple, usually glabrous, alternate; summer color variation from yellow-green to green and red-green; fall color also variable

Stem: twigs slender, brown to gray, with spurs

Buds: small and blunt, red to brown

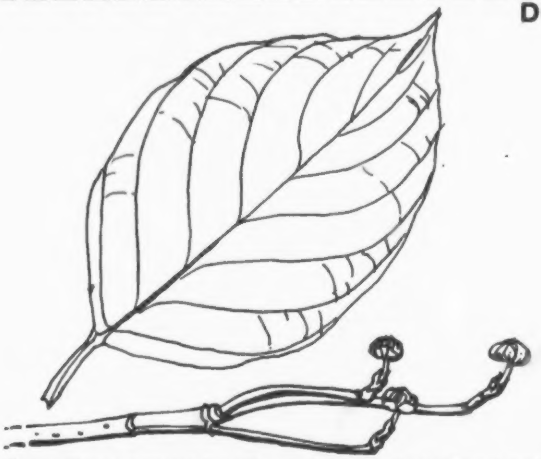
Size and form: extremely variable in size and form depending on species and cultivar; 8-50 feet

Flowers: pink to white, blooming before or with foliage in spring

Fruit: pome 2 inches in diameter or less; color variation from yellow through red to dark purple

Comments: hundreds of crabapple cultivars vary in size, flower, fruit, form and susceptibility to insects and disease; tolerant of many soil types; disease problems - apple scab, fireblight and rust; crabapples widely used as street trees

DOGWOOD



FLOWERING DOGWOOD - *Cornus florida*

Leaves: opposite, elliptical, with parallel venation; orange to deep red in fall

Stem: slender twigs with horizontal branching, green to red

Buds: growing upright on twigs; flower buds biscuit-shaped, gray

Size and form: 20-40 feet; flat-topped at maturity

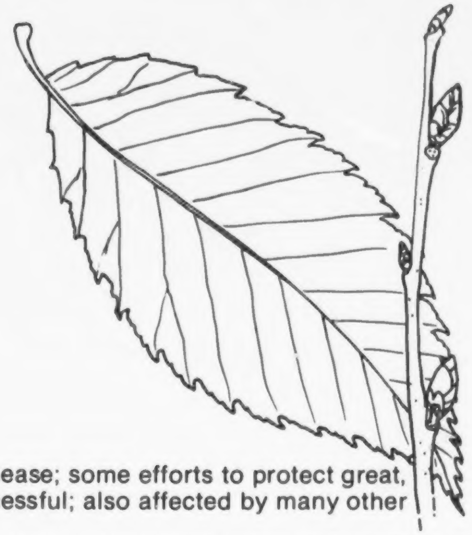
Flowers: very small yellow flowers surrounded by four large white bracts 2 inches in diameter, blooming before the leaves

Fruit: glossy red drupe

Comments: grows best in moist, well-drained soil with some shade, low pH; borers can be a problem; outer bracts often freeze before flowering in colder climates

ELM

AMERICAN ELM - *Ulmus americana*



Leaves: 3-6 inches long, alternate, double serrate, rough-textured; fall color golden-yellow

Stem: slender, red-brown twig; zigzag habit

Buds: ⅛ inch long, brown, adpressed to stem; terminal absent

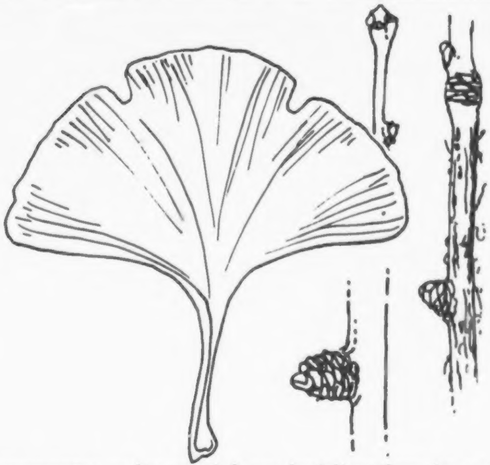
Size and form: 75-100 feet; vase-shaped habit; long overarching branches; spread often larger than height

Flowers: polygamo-dioecious; small red-brown clusters blooming in March

Fruit: ½ inch, tan samara ripening in May, June

Comments: a grand tree, but devastated by Dutch elm disease; some efforts to protect great, historic specimen trees from the disease have been successful; also affected by many other pests and diseases

GINKGO



GINKGO - *Ginkgo biloba*

Leaves: 2-3 inches, alternate, fan-shaped; yellow in fall

Stem: stout, tan to grayish, bark peels away in strings

Buds: mounded and brown, often on a spur

Size and form: 60-80 feet; highly variable in form

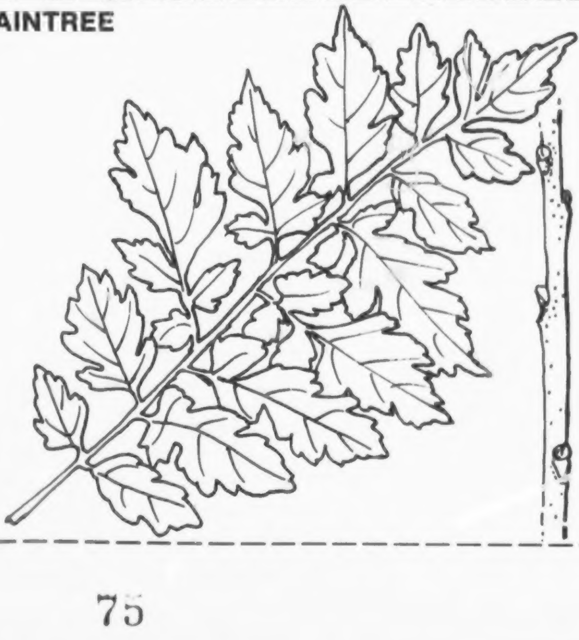
Flowers: dioecious, not ornamentally important

Fruit: naked seed, orange-brown, 1 inch in diameter; very strong, undesirable odor

Comments: quite pest-free; habit rather irregular; only males should be planted because of malodorous fruit borne on female trees

GOLDENRAINTREE

GOLDENRAINTREE - *Koelreuteria paniculata*



Leaves: alternate, pinnately or bipinnately compound, 7-15 leaflets; yellow in fall

Stem: stout tan twigs with prominent lenticels

Buds: grayish and teardrop-shaped; terminal absent

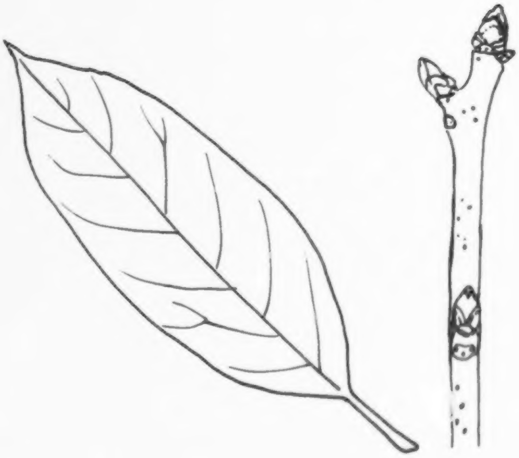
Size and form: 30-50 feet; dense and rounded

Flowers: long yellow panicles blooming in midsummer (July)

Fruit: brownish, papery capsules which persist

Comments: tolerant of drought and pollution; one of the few trees that flowers in summer

GUM



BLACK GUM - *Nyssa sylvatica*

Leaves: 2-5 inches, alternate, long, ovate, dark green and glossy; brilliant color - orange to dark red - in fall

Stem: slender, light brown twigs

Buds: reddish brown and pointed

Size and form: 30-60 feet; pyramidal and densely branched, becoming more rounded with maturity

Flowers: polygamo-dioecious, whitish, blooming at the same time as the leaves emerge; not ornamentally important

Fruit: small, black, ½-inch drupes, ripening in late September

Comments: does best in acid, well-drained soils; difficult to transplant; excellent fall color; students often frustrated when faced with the task of identifying this tree

HACKBERRY

HACKBERRY - *Celtis occidentalis*

Leaves: 2-5 inches, simple, greenish yellow, alternate, with serrate edge; yellow in fall

Stem: twigs slender, zigzag, greenish brown

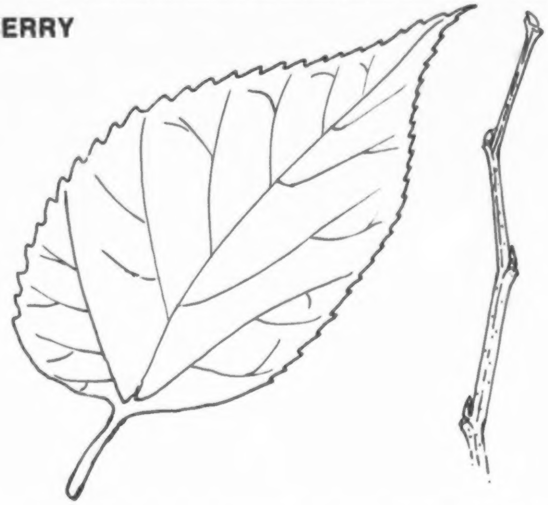
Buds: triangular, gray, adpressed to stem

Size and form: 60-90 feet; branches overarching; round to vase-shaped

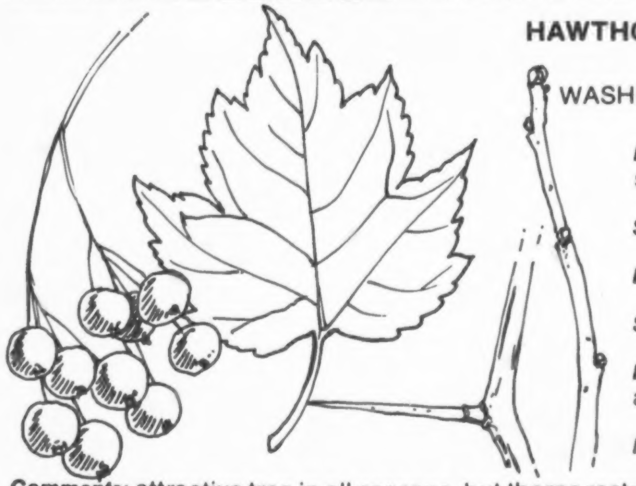
Flowers: small yellowish clusters, blooming in early May

Fruit: 1/3-inch, dark purple drupe, ripening in September and persisting

Comments: tolerant of harsh conditions; pests include hackberry nipple gall and witches' broom



HAWTHORN



WASHINGTON HAWTHORN - *Crataegus phaenopyrum*

Leaves: alternate, triangular with maple-like lobes, serrate; orange to purple in fall

Stem: slender, brown, with thorns 1-3 inches long

Buds: dome-shaped, red and glossy

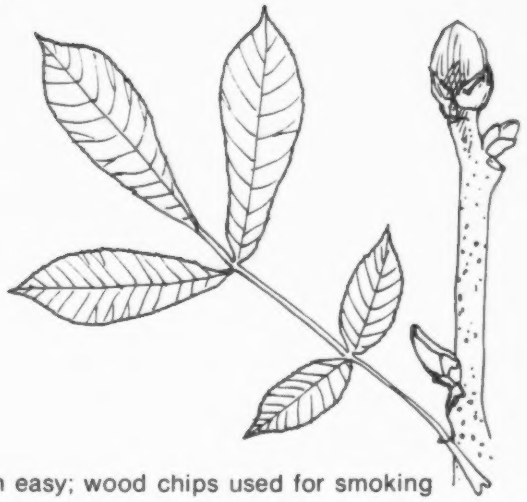
Size and form: 25-35 feet, oval to globular

Flowers: white, flat-topped clusters, blooming just after the leaves emerge

Fruit: red ¼-inch berries, persisting

Comments: attractive tree in all seasons, but thorns restrict planting; problems include rusts, fireblight and leaf spots

HICKORY



SHAGBARK HICKORY - *Carya ovata*

Leaves: alternate, pinnately compound, usually 5 leaflets; golden yellow in fall

Stem: stout, grayish brown, smooth; bark shaggy

Buds: large, ½-¾ inch, brown, exfoliating papery scales

Size and form: 60-100 feet; upright

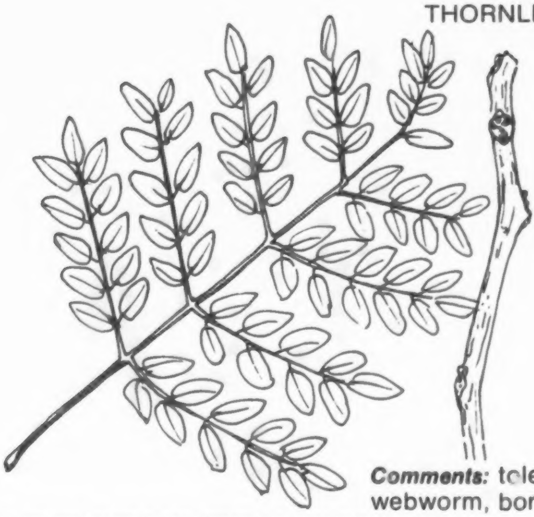
Flowers: yellow-green, pendulous catkins, blooming in mid-May; not ornamentally important

Fruit: globular nut 1½ inches in diameter, in thick, four-sectioned husk

Comments: bark adds character and makes identification easy; wood chips used for smoking meats and cheeses; difficult to transplant due to taproot

HONEYLOCUST

THORNLESS HONEYLOCUST - *Gleditsia triacanthos* var. *inermis*



Leaves: alternate, pinnately or bipinnately compound, 20-40 leaflets; excellent yellow fall color

Stem: zigzag, reddish brown twigs; enlarged nodes

Buds: small and hidden; terminal absent

Size and form: variable, depending on cultivars; 30-75 feet; globular or irregular in habit; often horizontal branching

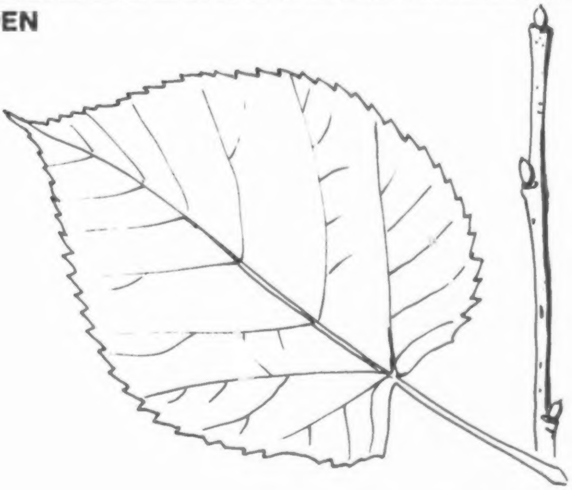
Flowers: polygamo-dioecious, yellow-green, fragrant, 4-inch spike blooming in June

Fruit: brown 8- to 12-inch pods; fruitless cultivars also grown

Comments: tolerant of dry alkaline soils and salt; pests include mimosa webworm, borers and cankers

LINDEN

AMERICAN LINDEN - *Tilia americana*



Leaves: 4-8 inches, alternate, cordate, with coarse, dull surface; yellow to brown fall color

Stem: slender, flaky gray to reddish

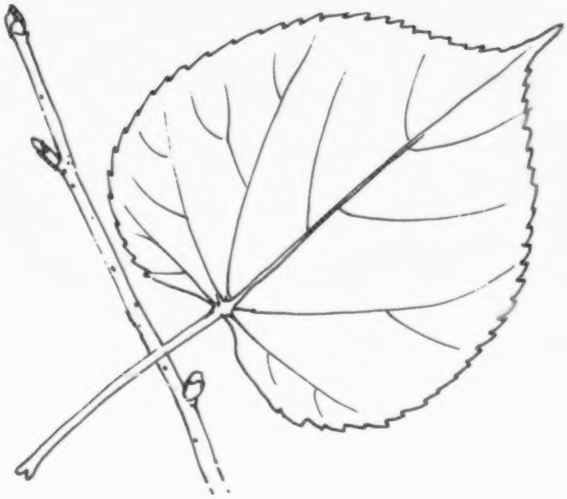
Buds: red, ⅛ inch, two-scaled

Size and form: 50-75 feet, sometimes larger; ovoid, somewhat upright

Flowers: pendulous, yellow, blooming in mid- to late June; fragrant, attractive to bees

Fruit: small woody balls attached to wings

Comments: pH adaptable; problems with aphids and Japanese beetles



LITTLELEAF LINDEN - *Tilia cordata*

Leaves: 2-3 inches, alternate, cordate, finely serrate; dark green in summer, yellow-green in fall

Stem: slender, brownish twigs

Buds: small, smooth; often a colorful yellow-red, otherwise greenish

Size and form: 40-60 feet, pyramidal; densely branched

Flowers: fragrant, yellow, blooming in late June

Fruit: same as *Tilia americana*; not ornamentally important

Comments: excellent street tree; many cultivars available; pest problems with Japanese beetles

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MAGNOLIA

SAUCER MAGNOLIA - *Magnolia soulangeana*

Leaves: 3-6 inches long, alternate; green in summer, yellow turning brown in fall

Stem: twigs gray, stout

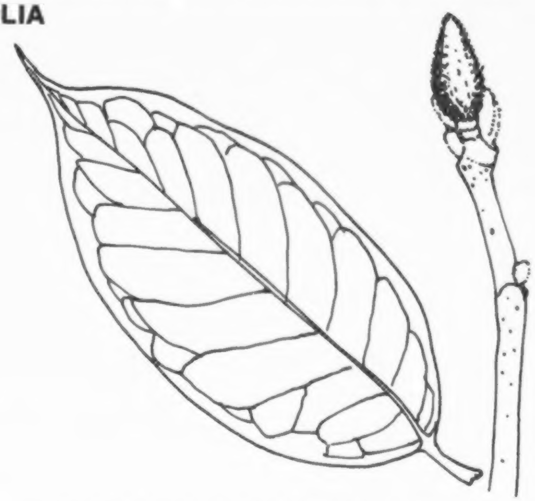
Buds: long, ½-¾ inch, greenish, very pubescent

Size and form: 20-40 feet; spreading; often low branching with multiple trunks

Flowers: large, 6-8 inches in diameter, pinkish white

Fruit: red aggregate of follicles, ripening in August

Comments: nice patio tree; attractive in bloom, but easily damaged by frost; petal and leaf drop a clean-up problem



MAPLE

NORWAY MAPLE - *Acer platanoides*

Leaves: 3-7 inches wide, opposite, palmate with five lobes, dark green; milky substance appearing when petiole is plucked from stem; attractive yellow fall color

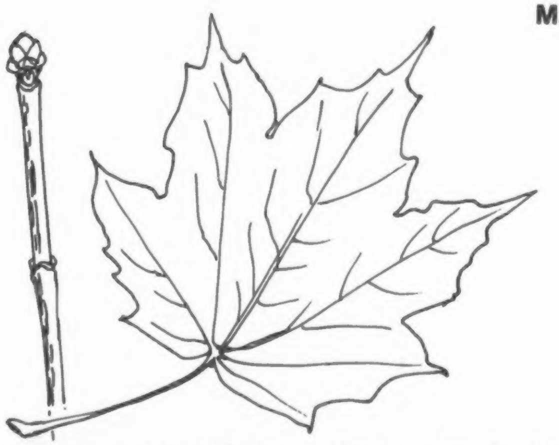
Stem: brown, smooth twigs

Buds: plump, ¼ inch long, reddish brown or green

Size and form: 40-60 feet; rounded habit

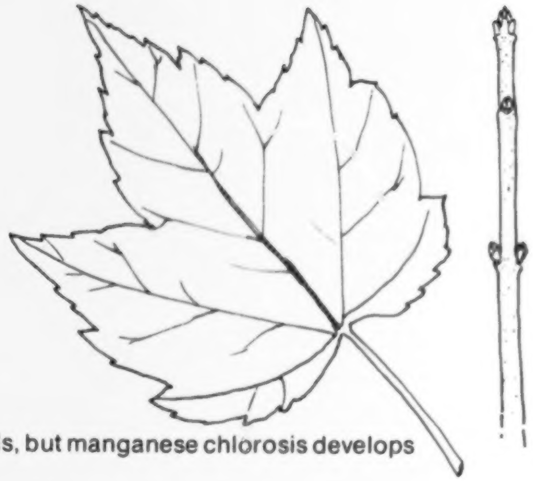
Flowers: bright yellow-green, blooming before leaves emerge

Fruit: double samaras spread like wings; ripening in September



Comments: cultivar 'Crimson King' known for its maroon summer foliage; verticillium wilt a common problem

RED MAPLE - *Acer rubrum*



Leaves: 2-4 inches wide, opposite, palmate; three (or five)-lobed; excellent red fall color

Stem: twigs green in summer, red in winter; slender and smooth

Buds: red, small, clustered

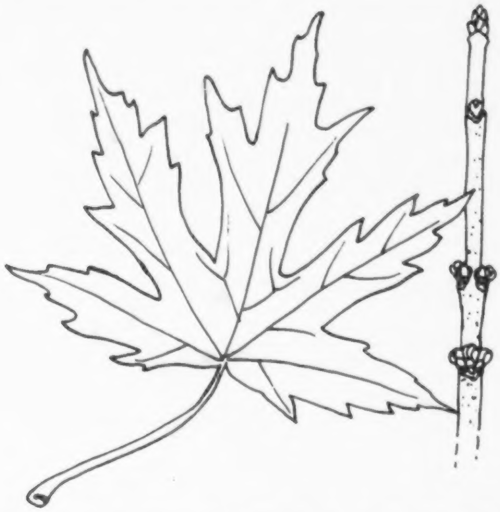
Size and form: 50-75 feet; mostly ovoid, but spreading

Flowers: red clusters, filamentous, blooming in late March

Fruit: paired samaras

Comments: many cultivars available; tolerant of damp soils, but manganese chlorosis develops in high pH

SILVER MAPLE - *Acer saccharinum*



Leaves: 3-6 inches, opposite, five lobes, palmate; yellow-green in fall, sometimes with a hint of red

Stem: twigs smooth, reddish brown to gray

Buds: red, small, clustered

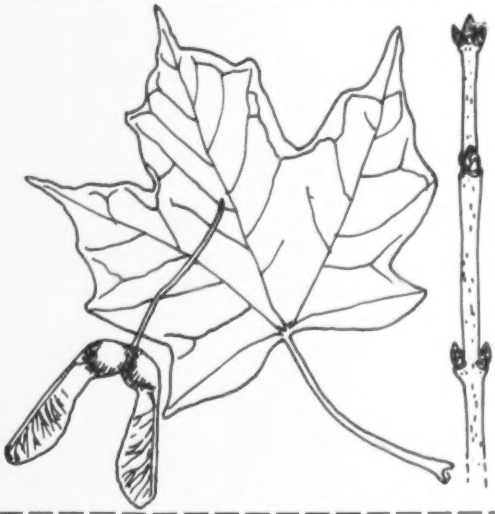
Size and form: 60-90 feet; irregular habit; lower branches pendulous, very fast-growing

Flowers: small clusters, red to yellowish, blooming before the leaves emerge

Fruit: paired samaras

Comments: a much maligned tree (some of it deserved); many pest problems known; often suffers from storm damage

SUGAR MAPLE - *Acer saccharum*



Leaves: 3-6 inches, opposite, palmate, three- to five-lobed; yellow-orange-red fall color, almost glowing

Stem: twigs smooth, tan

Buds: light brown, very thin and pointed

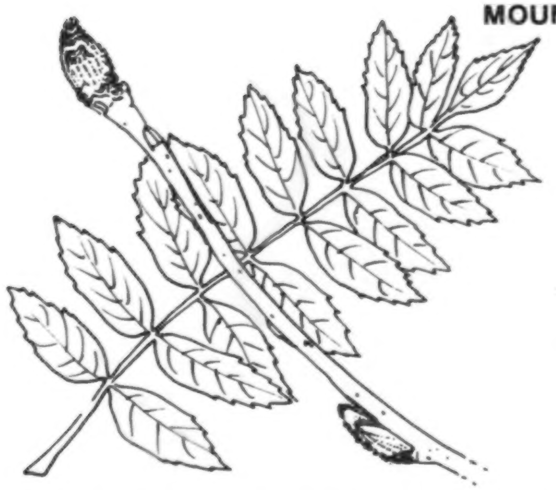
Size and form: 60-100 feet; variable in habit but usually ovoid

Flowers: small, pendulous clusters, yellow-green, blooming in April-May

Fruit: paired samaras

Comments: among the best for fall color; excellent shade tree, but not very tolerant of city conditions

MOUNTAINASH



EUROPEAN MOUNTAINASH - *Sorbus aucuparia*

Leaves: alternate, pinnately compound, 7-15 leaflets, serrate at tips; green to yellow-orange in fall

Stem: twigs grayish and pubescent

Buds: ½ inch long, maroon, fuzzy; appear stalked

Size and form: 25-50 feet; erect and oval, with pendulous branches

Flowers: white clusters blooming in May; malodorous

Fruit: orange-red clusters ripening in August-September; very attractive

Comments: very attractive specimen tree when healthy; borers and fireblight often serious problems

OAK

PIN OAK - *Quercus palustris*

Leaves: 3-6 inches long, alternate, pinnately lobed with deep sinuses; deep red in fall

Stem: twigs slender, reddish; branches with spurs (pins)

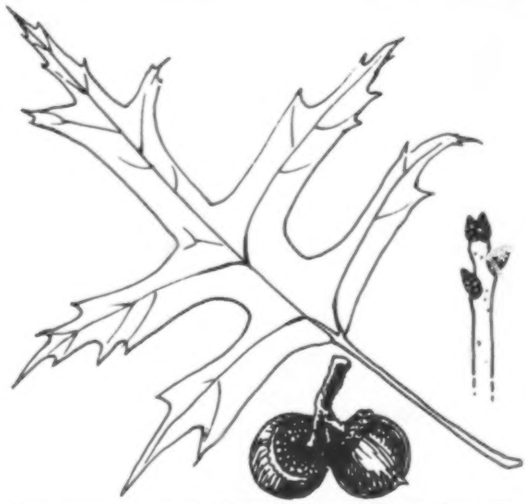
Buds: ⅛ inch, pointed, red-brown, clustered

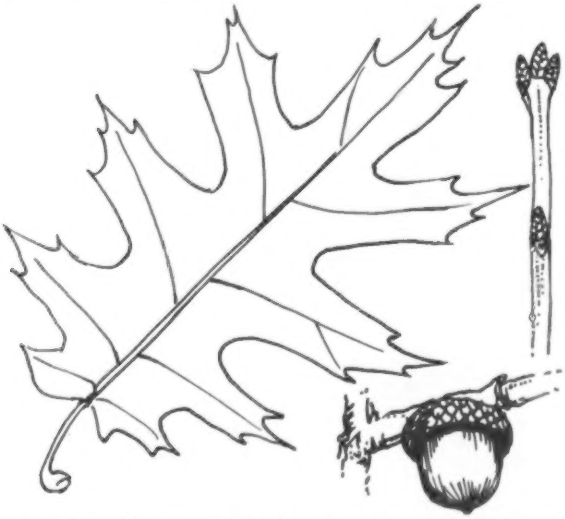
Size and form: 60-100 feet; upright; lower branches pendulous

Flowers: yellow-green catkins blooming in May

Fruit: red-brown acorn, ½ inch, ripening in fall

Comments: iron chlorosis very serious in alkaline soils





RED OAK - *Quercus rubra*

Leaves: 4-9 inches long, alternate, 7-9 lobes with pointed tips; russet red in fall

Stem: smooth, reddish brown

Buds: chestnut brown, pointed, clustered

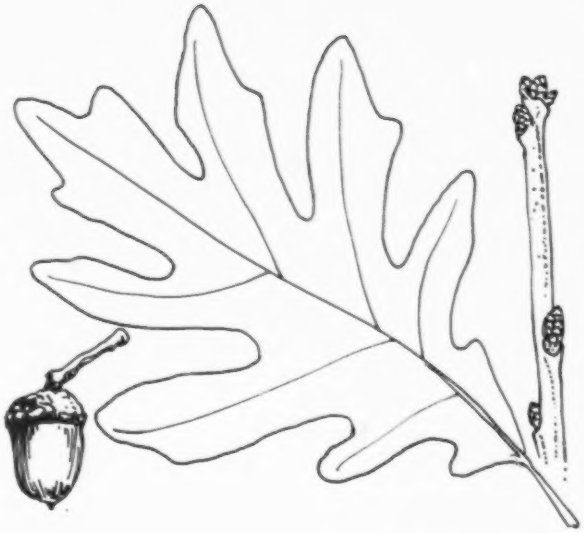
Size and form: 50-100 feet; upright and symmetrical

Flowers: yellow-green, blooming in May, not ornamentally important

Fruit: brown acorn, ¾-1 inch long, ripening in fall

Comments: one of the faster-growing oaks; excellent shade tree with few serious problems

WHITE OAK - *Quercus alba*



Leaves: 4-9 inches long, alternate, 5-9 lobes that are smooth and rounded; foliage brownish in fall, persists through winter

Stem: twigs stout, brown with purplish bloom

Buds: brown, blunt and clustered

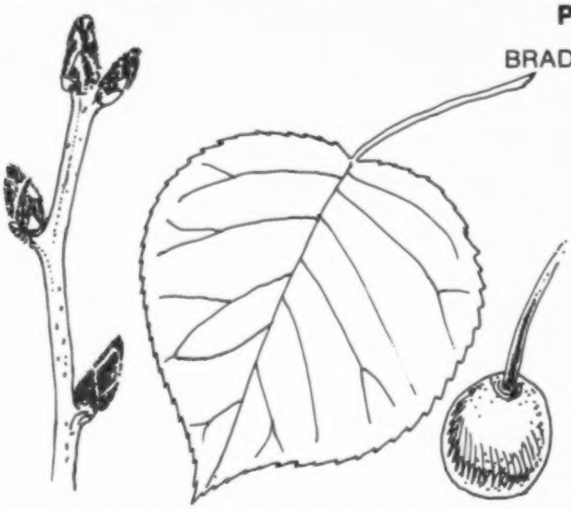
Size and form: 75-100 feet; upright and broadly rounded; stately form

Flowers: yellow-green, blooming in May; not ornamentally important

Fruit: ¾-inch-long acorn, one-quarter of it enclosed in cap

Comments: among the largest and most beautiful trees in the forest; very sensitive to construction injury (soil compaction and grade change)

PEAR



BRADFORD CALLERY PEAR - *Pyrus calleryana* 'Bradford'

Leaves: 2-3 inches, opposite; glossy, dark green in summer, scarlet to maroon in fall

Stem: twigs stout and brownish

Buds: tan and fuzzy

Size and form: 20-40 feet; stoutly pyramidal, very dense

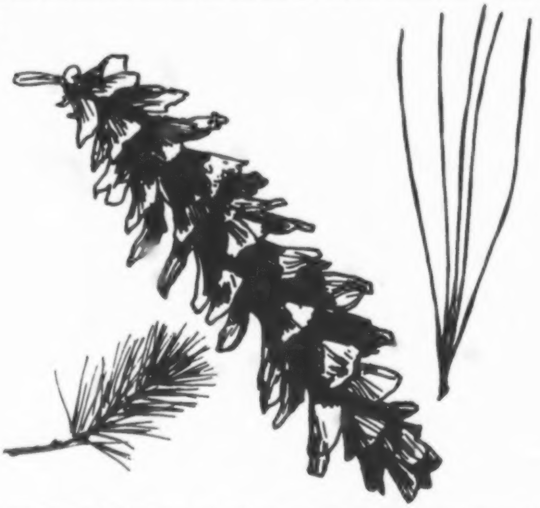
Flowers: white, blooming before the leaves emerge; spectacular in bloom

Fruit: ½-inch pome; not ornamentally important

Comments: good street tree, but prone to storm damage; many other cultivars now available

PINE

EASTERN WHITE PINE - *Pinus strobus*



Leaves: needles 3-5 inches long, five per sheath

Stem: twigs slender, green to gray

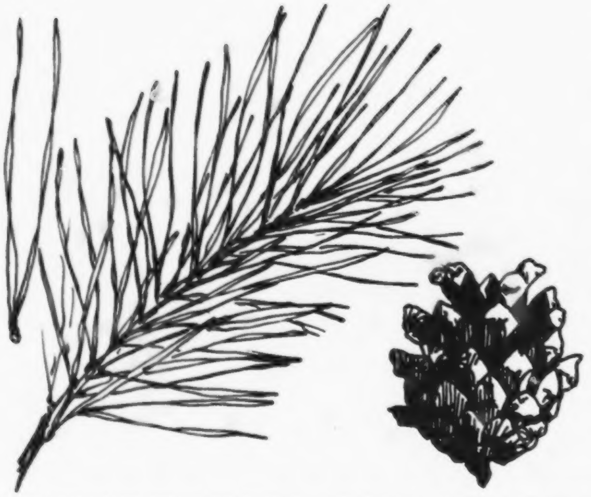
Buds: ovoid, ¼ inch, resinous, pointed

Size and form: 60-100 feet; pyramidal, and more irregular-shaped with age

Flowers: monoecious; not ornamentally important

Fruit: brown cone, 6-8 inches long, slightly curved

Comments: fast-growing, fine-textured pine; intolerant of pollution, salts



SCOTCH PINE - *Pinus sylvestris*

Leaves: needles 1-4 inches long, two per sheath, twisted, blue-green

Stem: twigs green to grayish brown; bark with orange tinge

Buds: ¼ inch, orange-brown, reflexed, resinous

Size and form: 40-75 feet; pyramidal when young, but opening with age

Flowers: monoecious; not ornamentally important

Fruit: cones 2-3 inches long, gray-brown

Comments: tolerates poor soils; some cultivars used as Christmas trees

REDBUD

EASTERN REDBUD - *Cercis canadensis*

Leaves: 2-4 inches across, heart-shaped, alternate; new growth reddish, dull yellow-green in fall

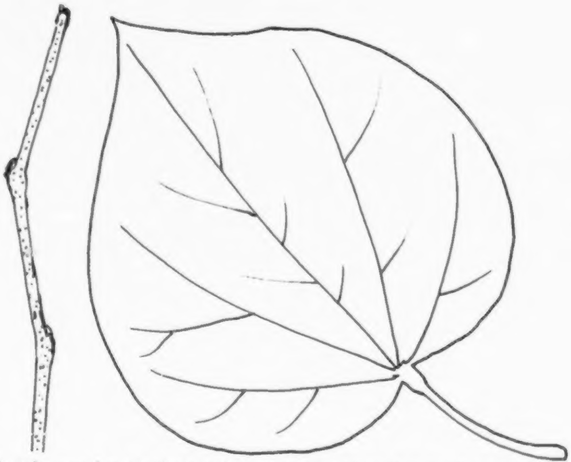
Stem: twigs zigzag, brown with prominent lenticels

Buds: small, dark, glossy; terminal absent

Size and form: 20-40 feet; spreading and flat-topped; often multi-stemmed

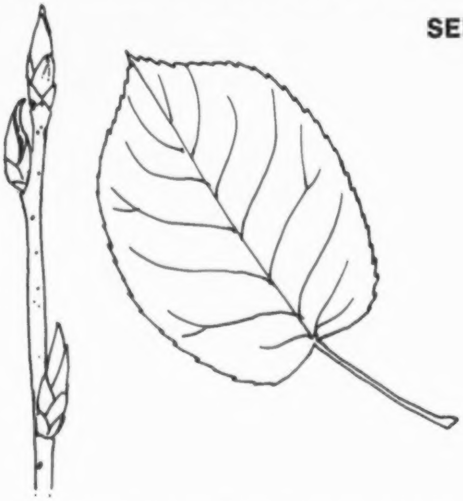
Flowers: purplish pink, blooming before the leaves emerge; often produced on trunk and branches

Fruit: leguminous pod, 2-3 inches long, brown; ripening in October



Comments: an excellent specimen tree; tolerates sun, shade and a variety of soils; tends to be rather short-lived due to canker problems and verticillium wilt

SERVICEBERRY



ALLEGHENY SERVICEBERRY - *Amelanchier laevis*

Leaves: 1-3 inches long, simple, finely serrate; dull green in summer, orange to red in fall

Stem: slender, gray, slightly exfoliating

Buds: narrow, cigar-shaped, reddish brown

Size and form: 20-35 feet; often multi-stemmed; rounded habit

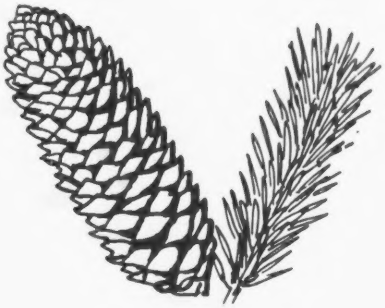
Flowers: white, upright, blooming in late April

Fruit: ½ inch; red, turning purple when ripe; edible

Comments: excellent four-season tree; somewhat intolerant of soil compaction

SPRUCE

COLORADO SPRUCE - *Picea pungens*



Leaves: stiff needles ¾-1¼ inches long, spirally arranged over stem

Stem: orange-brown

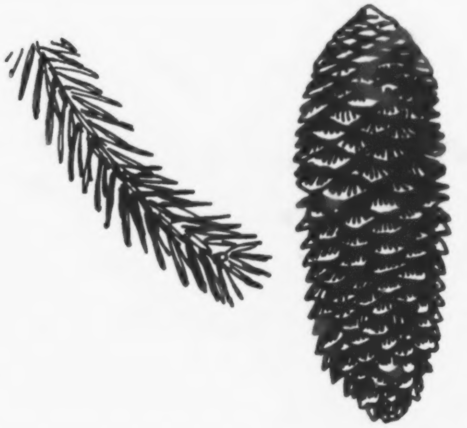
Buds: broadly conical, blunt, tan

Size and form: 75-100 feet; narrow, dense, pyramidal

Flowers: monoecious; inconspicuous

Fruit: light tan, oblong cone, 2-5 inches long

Comments: somewhat drought-tolerant; blue cultivars most widely used in home landscape; some insect problems; sometimes trees are blown over in high winds



NORWAY SPRUCE - *Picea abies*

Leaves: needles ½-1 inch long, stiff, bluntly pointed, not as erect as those of Colorado spruce

Stem: twigs slender, orange-brown

Buds: light brown, ¼ inch long, rosette-shaped

Size and form: 50-75 feet; pyramidal with pendulous branchlets

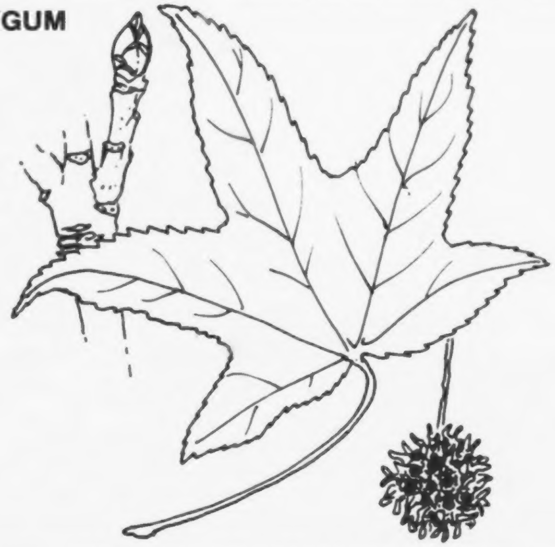
Flowers: monoecious; inconspicuous

Fruit: cone 4-6 inches long, brown

Comments: somewhat overused in the landscape; scrappy-looking with age

SWEETGUM

SWEETGUM - *Liquidambar styraciflua*



Leaves: 4-7 inches wide, alternate, palmately lobed, star-shaped; fall color variable - yellow to deep purple

Stem: twigs aromatic, gray, with corky wings

Buds: ½ inch, scaly, orange-brown, glossy

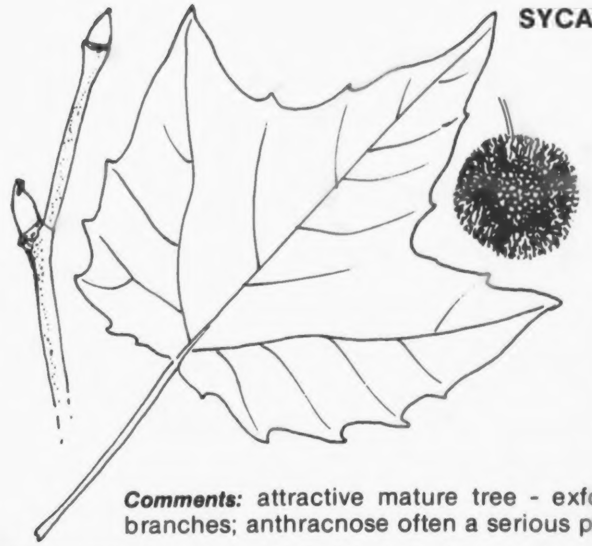
Size and form: 50-75 feet; conical, becoming ovoid

Flowers: monoecious, green, not ornamentally important

Fruit: globular, prickly, 1 inch in diameter

Comments: attractive shade tree when used appropriately; iron chlorosis in alkaline soils; insect/disease problems occur when tree is stressed

SYCAMORE



SYCAMORE - *Platanus occidentalis*

Leaves: 4-10 inches wide, leathery, hairy, palmately lobed (3-5 lobes), alternate; dull green in summer, yellow-brown in fall

Stem: stout, zigzag, tan-colored

Buds: smooth and blunt, ¼-½ inch long, reddish purple

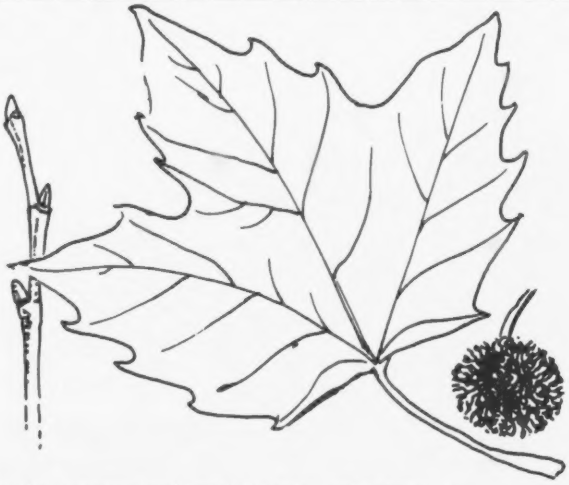
Size and form: 75-100 feet; wide-spreading

Flowers: small clusters, blooming when leaves emerge; not ornamentally important

Fruit: tan-colored ball, 1-2 inches in diameter

Comments: attractive mature tree - exfoliating bark exposes white patches on trunk and branches; anthracnose often a serious problem; many other insect and disease problems

LONDON PLANETREE - *Platanus acerifolia*



Leaves: 4-8 inches wide, leathery, hairy, palmately lobed (3-5 lobes), alternate; dull green in summer, yellow-brown in fall

Stem: stout, zigzag, tan-colored

Buds: smooth and blunt, ¼-½ inch long, reddish purple

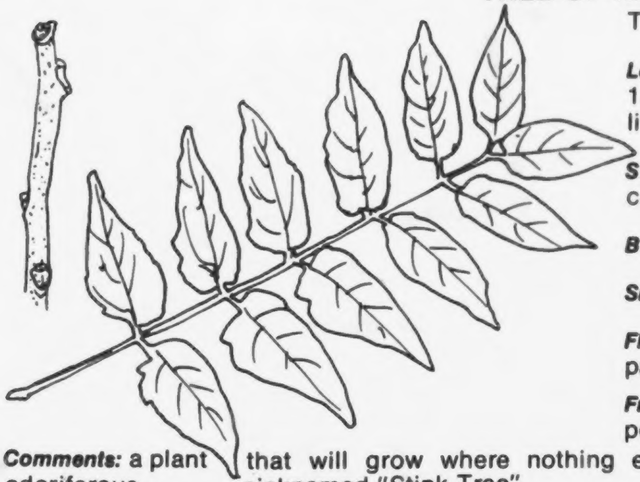
Size and form: 60-80 feet; upright when young, opening with age

Flowers: small clusters, blooming when leaves emerge; not ornamentally important

Fruit: tan-colored ball, 1-2 inches in diameter

Comments: bark exfoliates, exposing an olive-green to cream-colored trunk; resistant to anthracnose; sometimes rather short-lived in city conditions

TREE-OF-HEAVEN



TREE-OF-HEAVEN - *Ailanthus altissima*

Leaves: 18-24 inches long, pinnately compound, 15-25 leaflets, alternate; dark green in summer, little fall color, some reddish

Stem: stout, yellow-brown; nasty odor when crushed

Buds: small, semi-spherical, brown; large leaf scar

Size and form: 40-60 feet; spreading, coarse habit

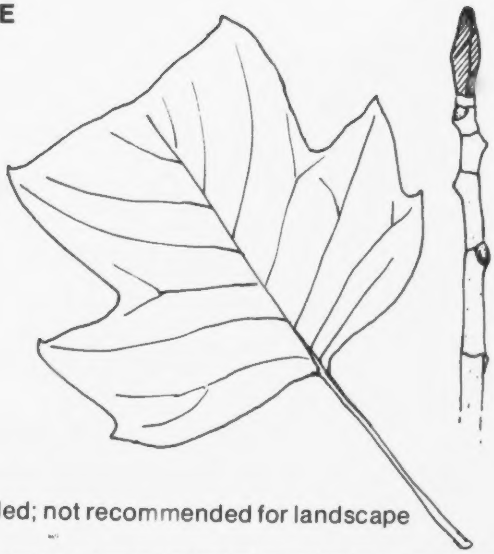
Flowers: dioecious, 8- to 12-inch-long yellow-green panicles, blooming in June

Fruit: samaras in large clusters turning brownish; persisting

Comments: a plant that will grow where nothing else will; weak-wooded; odoriferous - nicknamed "Stink Tree"

TULIPTREE

TULIPTREE - *Liriodendron tulipifera*



Leaves: 3-6 inches, tulip-shaped, glossy, alternate; rich yellow fall color

Stem: twigs smooth, reddish to light brown, aromatic

Buds: valvate, terminal, red-brown, covered with a bloom

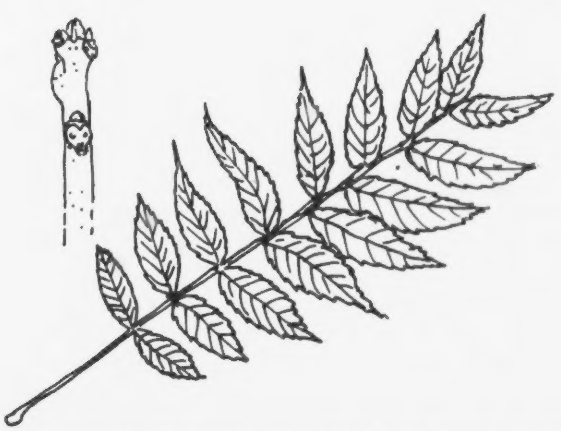
Size and form: 75-100 feet; fast-growing; somewhat columnar

Flowers: large, single, upright, pinkish orange, blooming in June

Fruit: aggregate of tan samaras ripening in October

Comments: can grow to a good size; somewhat weak-wooded; not recommended for landscape plantings

WALNUT



BLACK WALNUT - *Juglans nigra*

Leaves: alternate, pinnately compound, 15-23 serrate leaflets; late to leaf out in spring and early to drop leaves in fall, yellowish fall color

Stem: stout, tan twigs with large leaf scars

Buds: naked, woolly, dark grayish

Size and form: 75-100 feet; irregular habit

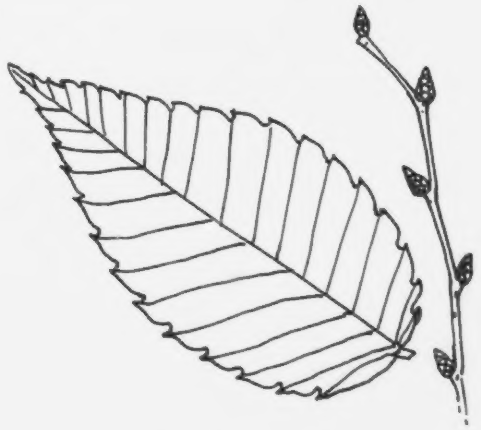
Flowers: monoecious; yellow-green; not ornamentally important

Fruit: very hard nut enclosed in a 2-inch, bright green, round husk; ripening in September

Comments: hard wood very valuable; not very good as a landscape plant; may cause toxicity problems to nearby plants

ZELKOVA

JAPANESE ZELKOVA - *Zelkova serrata*



Leaves: 1½-2 inches long, simple, serrate, alternate; deep green in summer, yellow to red in fall

Stem: slender brown twigs, pubescent when young

Buds: brown, pointed, ¼ inch long, at 45° angle to stem

Size and form: 50-75 feet; low-branching, spreading habit, often wider than tall; sometimes multi-stemmed

Flowers: in clusters, blooming in April-May, not ornamentally important

Fruit: very small, ⅛-inch drupe, ripening in fall

Comments: attractive for its flaky bark and excellent fall color; introduced to replace the American elm but has never gained popularity

CHAPTER 9

Identification and Treatment of Tree Problems

Objectives

This chapter is intended to provide some introductory information on how to diagnose and treat various types of tree disorders.

1. Understand what is meant by tree health management.
2. Learn the basic steps and methods used in diagnosis of disorders.
3. Become familiar with the various signs and symptoms of disease and pest problems.
4. Learn the major classifications of disease, insect damage and environmental injuries.
5. Understand the principles of Integrated Pest Management.
6. Know how to calibrate a sprayer, and learn the basics of applying pesticides to trees.

Tree Health Management

For years doctors have known that stress can predispose a person to illness. Stress can result from physical problems such as poor eating habits, insufficient sleep, or lack of exercise. Other causes of stress can be mental or emotional.

The situation is quite similar with plants. Trees that are under stress are more prone to invasion by insects and disease. Once physiologically weakened, the tree may succumb to secondary pathogens or pests.

It is important to maintain the health and vigor of a tree to help prevent diseases and other disorders. A tree in good health is better able to withstand insects and pathogens that can prove fatal to a weak tree.

The first step in tree health management is to choose plants that are appropriate for the site in which they are expected to grow. One does not expect tropical plants to survive in a Wisconsin landscape. Plants must be hardy to tolerate winter weather. Besides cold, there are many other environmental factors: soil type, pH, annual rainfall, sunlight, temperature extremes — all are important considerations. Thus a forest understory plant such as dogwood would not be expected to do well as an urban street tree.

Tree health management includes other practices which help maintain the vigor of the tree. Adequate moisture and proper drainage must be provided. Many tree problems stem from poor root health. Since water and minerals are taken up through the roots, any problems such as soil compaction, poor drainage or drought will affect the entire plant.

Regular fertilization will also help keep the tree actively growing. Trees in an urban or landscape situation frequently do not get sufficient levels of vital elements. A vigorously growing plant will generally be one that is in good health, while a tree that is growing very little is probably just surviving.

Plant pathologists and entomologists agree that the primary step in prevention and treatment of tree problems is maintenance of a tree's health. Minimizing stress is the key to keeping a tree in good health.

Diagnosis of Tree Problems

Accurate diagnosis of tree problems requires a little investigative work. The tree must be examined from many perspectives. It is important to keep an open mind and not to diagnose the situation prematurely. Remember that tree problems frequently are the result of several contributing factors.

Unlike people, trees cannot tell us "where it hurts" or when the illness started. For this reason, the arborist must rely on the homeowner to provide background information. Unfortunately, most homeowners are not trained in plant care, and they may give inaccurate information. Frequently, all but the final symptoms go unnoticed. The homeowner may report that the tree "just died overnight." The tree specialist must learn to ask key questions that can help to determine what caused the problem. One might discover, for example, that trenching for a pipeline severed 50% of the tree roots several years previously.

After gathering background information, the arborist must examine the plant in its environment (Figure 9.1). The first perspective to be investigated is from a distance. Look at the condition of other plants in the area. Look for similar symptoms. Notice the climatic conditions, drainage patterns, and soil types. Does the problem appear to be specific to the plant in question or generalized over the entire area? Figure 9.2 shows a group of dead and declining trees from a distant perspective.

Figure 9.1. "*This* tree? No, ma'am, I don't think a little fertilization and pruning will do the trick."

Figure 9.2. Looking at plants within their total environment may provide clues for diagnosis.

The second point of view involves a close examination of the tree as a whole. There are many places to look for symptoms. Check for dieback in the crown and note whether it is universal or limited to particular limbs. Look for injuries to the trunk or branches. Check the foliage color and condition. Measure the twig extension growth over the past five years. This may provide the answer to when the problem began. Look for problems which may affect the root zone. Remember that any one symptom may be caused by a variety of injuries or pests. The correct course of action can be decided only when all the symptoms and clues are combined (Figure 9.3).

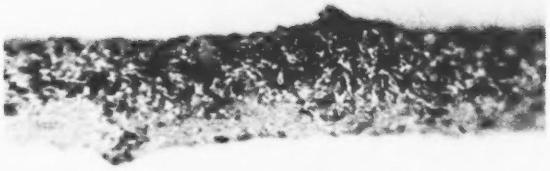


Figure 9.3. Close examination may reveal problems such as this scale on the twig.

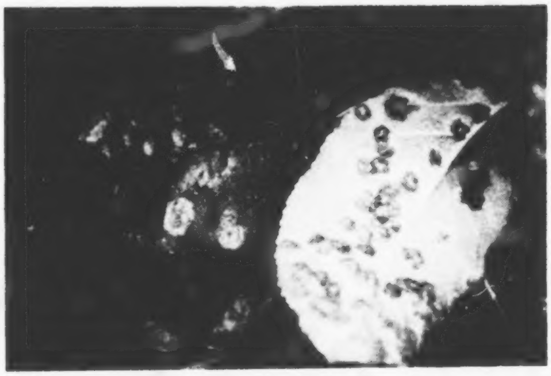


Figure 9.4. Leaf spot is one symptom of cedar-apple rust on apples, crabapples, and hawthorns.

Frequently the naked eye cannot catch all the symptoms. Spider mites, insect eggs and fungal fruiting bodies, for example, cannot be seen without magnification. Most tree professionals carry a pocket hand lens for use in diagnosing tree problems. Such a close-up perspective sometimes yields the final answer. At other times, in order to confirm the presence of a particular disease-causing organism, samples must be sent to a plant disease clinic for laboratory tests.

In diagnostics knowledge and experience are the most important tools. The professional must be able to identify the plant and know its characteristics and sensitivities. The arborist must be aware of what is "normal" for that species. It helps to know the characteristic problems of each species and what pests and diseases have been severe in a given year.

An experienced diagnostician will carry a number of tools to help diagnose tree problems.

- pruning saw and hand pruners: to look at cambium and inner wood
- knife: to expose symptoms under the bark or cut small sections for close examination
- spade: to dig around the trunk or in the root zone
- soil auger: to examine the soil situation in the root zone
- increment borer: to look at growth patterns or decay in the wood
- hand lens: for magnification of very small organisms or objects
- binoculars: to look at foliage and other features that cannot be seen from the ground

SYMPTOMS AND SIGNS

Many diseases and pests of plants are named for the damage they cause and the plant affected; for example, oak wilt, hawthorn leaf blight, and holly leaf miner. The tree service worker needs to become familiar with the various signs and symptoms of tree problems. Remember that almost never can a problem be diagnosed by a single symptom. Wilting, for example, can be the result of drought, root problems or various fungal or bacterial organisms. Some symptoms of plant disorders are described in the following section.

Leaf spot - spots of dead tissue on the foliage (Figure 9.4). (If the dead area in the center falls out, the spots are called "shot holes.") The shape and size may be characteristic of the causal agent; zonate spots with concentric (bull's-eye-like) areas are frequently of fungal origin.

Leaf blotch - dead areas on the foliage, usually irregular in shape and larger than leaf spots

Blight - necrotic (dead) portions of a plant, especially of young, growing tissues such as leaves and twigs

Scorch - browning and shriveling of foliage around the margin or between the veins due to heat and intense sunlight

Wilt - drooping stems and foliage due to a lack of water within the plant

Canker - localized dead stem tissue, often shrunken and discolored (Figure 9.5)

Damping-off - rotting at the base of seedlings

Stunting - reduced plant growth

Gummosis - exudation of sap from wounds or other bark openings

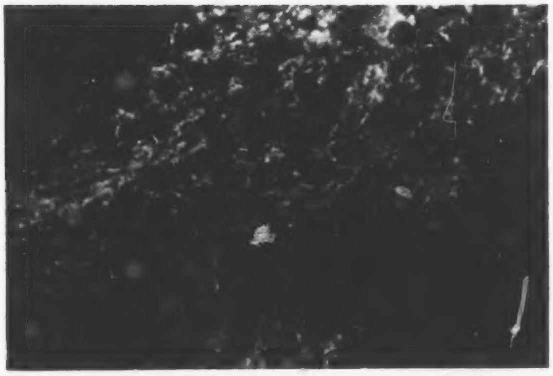


Figure 9.5. Nectria canker is caused by a fungus with orange fruiting bodies.

Oedema - watery swelling or gall due to abnormal internal water conditions; after bursting, may appear similar to rust

Rust - orange or reddish brown pustules on leaves or stems; cause - a particular group of fungi

Smut - black powdery pustules or streaks on soft plant tissues; cause - a particular group of fungi

Powdery mildew - white or grayish fungal growth on the surface of stems or foliage

Downy mildew- spores and spore-bearing structures from fungal growth beneath the leaf surface; usually darker in color than powdery mildew

"Water-soaked" - darkened plant tissue that appears wet or oily

Galls - areas of swollen plant tissue that had been invaded by parasites

Vascular discoloration - darkening of the vascular elements in wood (Figure 9.6)

Witches' broom - abnormal growth of a large number of secondary shoots forming a "broom"

Chlorosis - yellowing of normally green tissues due to lack of chlorophyll

Necrosis - death of tissue

Dieback - large portions of dead plant parts

DISEASE-CAUSING ORGANISMS

Fungi

The vast majority of parasitic diseases of plants are caused by fungi. This is not to say, however, that "most fungi cause disease." Quite the contrary! Most fungi are either beneficial or of little consequence to people. Fungi are used in processing cheeses, bread, wines and antibiotics. Fungi are also essential in breaking down and recycling organic matter in the soil.

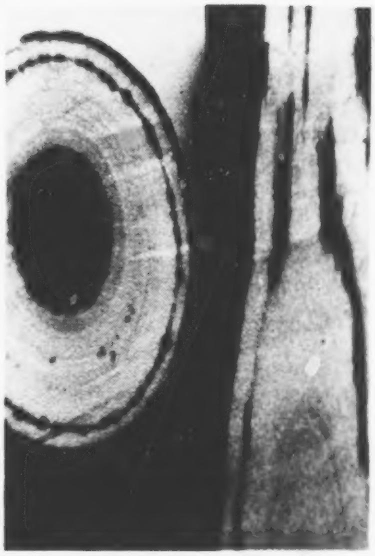


Figure 9.6. Vascular discoloration is one of the symptoms of verticillium wilt.

Fungi are non-photosynthesizing plants which must obtain their nutrients from other sources. (They cannot manufacture their own food.) In some cases fungi become parasitic on living plant tissues and thereby cause disease. There is a wide spectrum of fungi which cause disease; most plants are susceptible to at least one. The severity and extent of the disease depends on the resistance of the plant, the fungus, and environmental conditions. Most fungal diseases develop rapidly in a warm, moist environment.

Some fungi invade only the succulent tissues of the plant, such as leaves, stems and fruit. Leafspots are an example. Other diseases include anthracnose, powdery mildew, tip blight, and scab. (See examples of some of these problems in Figures 9.7-9.9.)

Some fungi attack stem tissue and cause girdling of the plant by stopping the upward and downward flow of water and nutrients. These are called canker diseases. Some of the most severe fungal diseases are the result of fungal invasion in the vascular elements of the plant. This group includes verticillium wilt, chestnut blight, phloem necrosis and Dutch elm disease. Each of these diseases usually causes death of the plant.

Bacteria

Like fungi, many bacteria are important to human beings and vital to the environment. Only a few cause plant disease. Many bacterial diseases cause rot. Soft rot diseases in ornamentals break down and decay tissues. The diseased areas may have a water-soaked appearance or a foul-smelling odor. Two of the most common diseases caused by bacteria are crown gall and fireblight, shown in Figures 9.10 and 9.11.

Other Disease-causing Organisms (Pathogens)

In addition to pathogenic fungi and bacteria, other organisms too can cause disease. Certain viruses cause ringspot, yellowing and stunt diseases. Mycoplasmas have been found to be the cause of some disorders. Certain serious plant problems are caused by microscopic "worms" called nematodes. Most nematodes live in the soil, but some invade aerial portions of plants. Nematodes have long been known to cause problems in warm, southern climates. But now many plant pathologists also expect to see more nematode-caused problems in the North.

Insects and Other Animal Pests

INSECTS

Insect pest problems are one of the biggest headaches that an arborist must confront. Insects cause more plant disorders than any other animal does. Insects also often serve as *vectors* or carriers for disease organisms; that is, they provide means of dissemination or invasion. Insects have

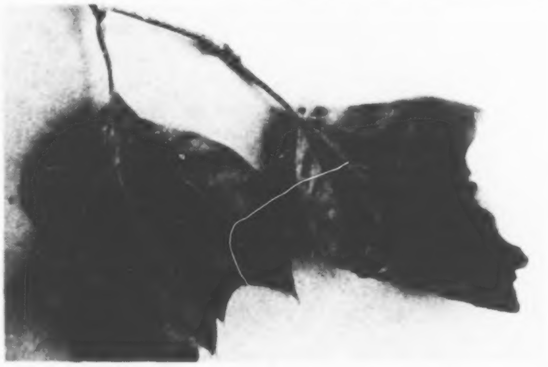


Figure 9.7. Anthracnose on London planetree.

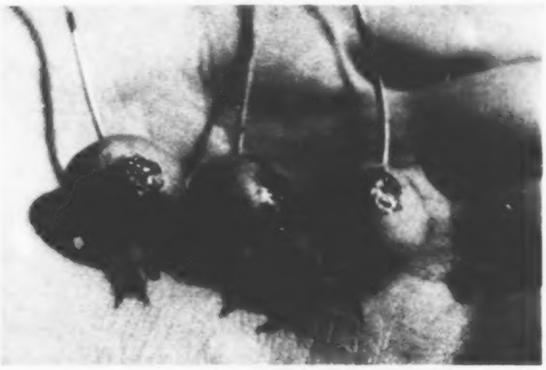


Figure 9.8. Apple scab symptoms appear on fruit as well as the leaves.

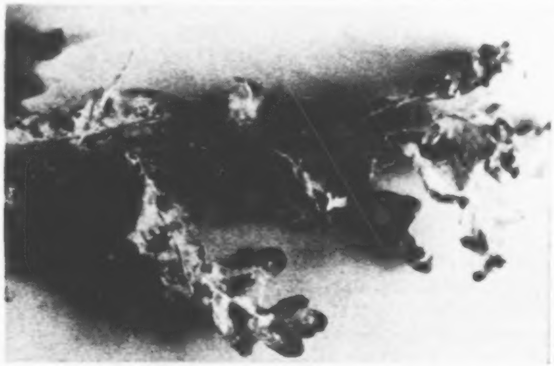


Figure 9.9. Powdery mildew is mostly a cosmetic problem, doing little damage to the plant.

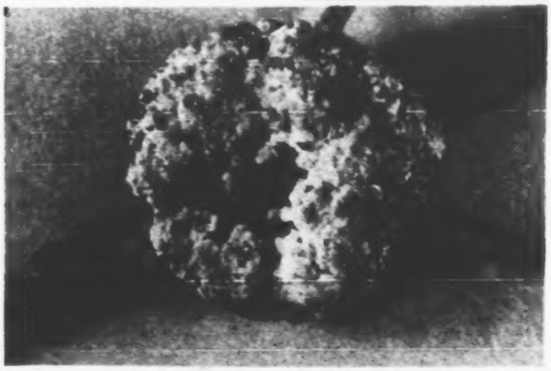


Figure 9.10. Crown gall is common on euonymus.

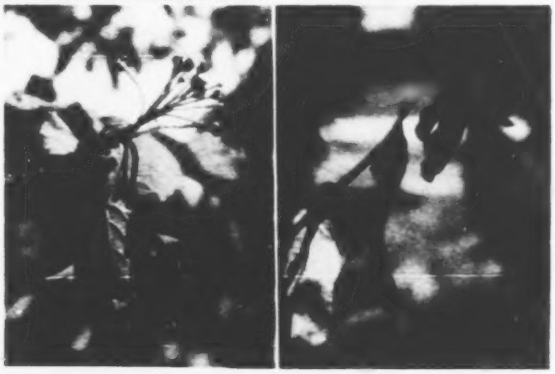


Figure 9.11. The "shepherd's crook" is an early symptom of fireblight.

complicated life cycles, one stage of which may cause problems while the next does not. Control measures must be properly timed to reach the insect at the problem stage.

Most of the insect damage to plants is the result of feeding. (One notable exception is the damage caused by ovipositing or egg-laying of the cicada.) The nature of feeding damage depends upon the type of mouthparts. Insect mouthparts are adapted for either chewing or piercing and sucking. The damage done can be diagnostic symptoms of certain types of insects.

Chewing insects have mouthparts which rub together and macerate the food material. Some caterpillars, webworms, beetles and weevils are known to chew the foliage of plants. Some insects devour the whole leaf, while others eat only the intervenal tissue and leave a skeletonized leaf. Leaf miners feed between the upper and lower leaf surfaces creating tunnels. Another group of chewing insects is the borers which feed and tunnel under the bark.

The second type of insect feeding is piercing and sucking. Mouthparts are adapted with a long stylet that pierces the cell and sucks out the contents. Symptoms of this type of feeding include chlorosis, stippling and sometimes distortion. Sometimes feeding of this type results in gall formation on foliage or stems. Examples of piercing-sucking insects are scales, aphids, mealybugs and true bugs.

ORDERS OF INSECTS

Insects are classified much the same as plants, each insect having a genus and a species name. In discussing groups of related insects, however, most often the *order* names are used. The order is the classification level that divides the insects into commonly known types. The orders of insects that are of concern to arborists are listed as follows:

Hemiptera - true bugs

Orthoptera - grasshoppers, locusts

Thysanoptera - thrips

Homoptera - leafhoppers, aphids, scales

Coleoptera - beetles

Lepidoptera - butterflies, moths

Diptera - flies

Hymenoptera - bees, wasps, ants

Hemiptera

The order Hemiptera includes what are known as the "true" bugs. Two types of bugs are most often the cause of problems for arborists — lace bugs and plant bugs. Lace bug feeding on the lower leaf surface creates a stippled appearance. Two common pests are the hawthorn lace bug and the sycamore lace bug (Figure 9.12). Plant bugs that cause damage feed on newly expanding foliage. The damage may range from a few holes in the leaves to complete defoliation, depending on the species and severity of infestation.

Homoptera

Many plant pests are included in the order Homoptera. Aphids, leafhoppers, cicadas, psyllids, scales, mealybugs and whiteflies are all in this group. Each of these insects has the piercing-sucking mouthparts which cause damage to plants by extracting sap from the plant tissues. Leafhoppers feed on the lower leaf surfaces and cause curling or epinasty (distorted growth) of the leaf. Hackberry nipple gall (Figure 9.13) is caused by the feeding of a tiny psyllid on the undersides of hackberry leaves.

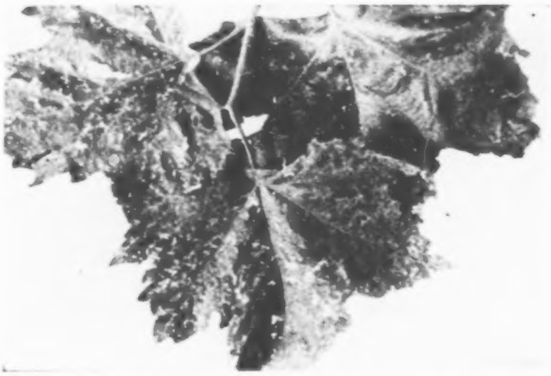


Figure 9.12. Sycamore lace bug damage on London planetree.

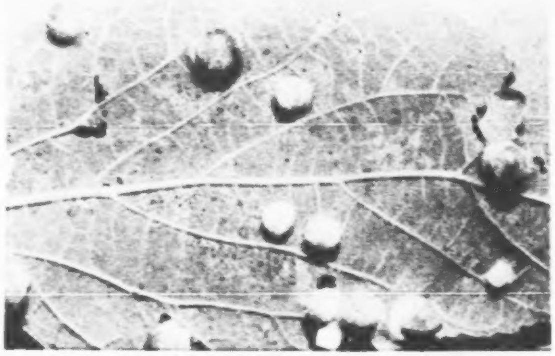


Figure 9.13. An identifying characteristic of American hackberry: the presence of hackberry nipple gall on the undersides of the leaves.

Aphids, which come in many sizes and colors, are pests to hundreds of kinds of plants. Generally aphids feed on and cause damage to phloem tissue. Due to their potential for rapid reproduction, aphid populations can grow extremely large. It is not unusual to see plants completely covered with aphids. Aphids and other homopteran insects may excrete honeydew when feeding. On this sticky substance a dark, sooty mold grows, creating a second unsightly problem.

Some aphids cause galls on woody plants. Two examples of galls caused by aphids feeding on shoot tips are the Cooley spruce gall and the eastern spruce gall (Figure 9.14).

One of the major insect problems on trees is scales. Scales usually feed on young stems. Some cause merely cosmetic damage, while others can be fatal. Some scales are quite obvious, while others are difficult to spot. Control is often difficult because of the problem of proper timing of spray applications. One very common scale is cottony maple scale, known for its popcorn-like appearance (Figure 9.15). Cottony maple scale attacks many shade trees, especially silver maple.

Some of the other scales that are common pest problems are Fletcher scale, San Jose scale, magnolia scale, oyster shell scale, pine needle scale, pine tortoise scale and euonymus scale. Several of these can be quite serious. Oyster shell scale is sometimes fatal to the plant. Also, severe infestations of euonymus scale (Figure 9.16) have been known to wipe out large plantings of euonymus.

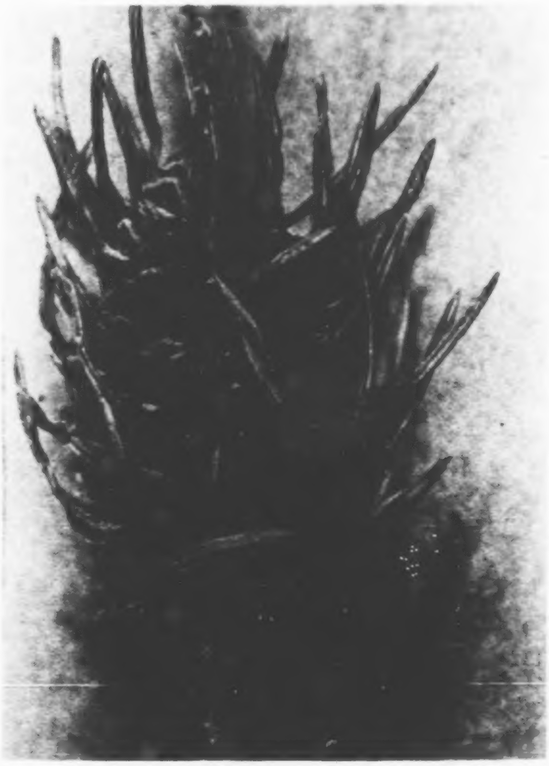


Figure 9.14. Damage to Norway spruce from the eastern spruce gall aphid.

Coleoptera

Another large order of insects is Coleoptera, the beetles. There is a wide diversity of damage done by members of this order, one of which is the infamous Japanese beetle. It has been said that Japanese beetles will eat anything green. Though

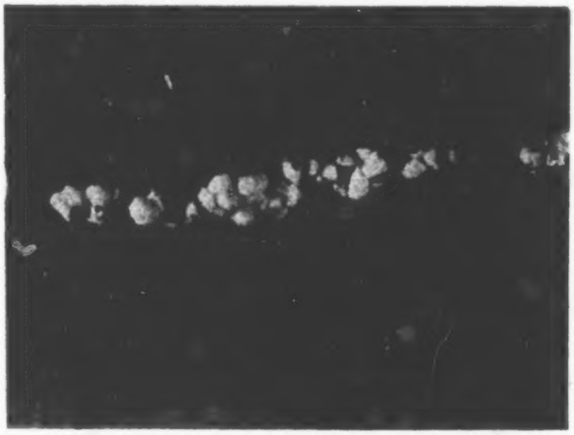


Figure 9.15. Cottony maple scale on hawthorn.

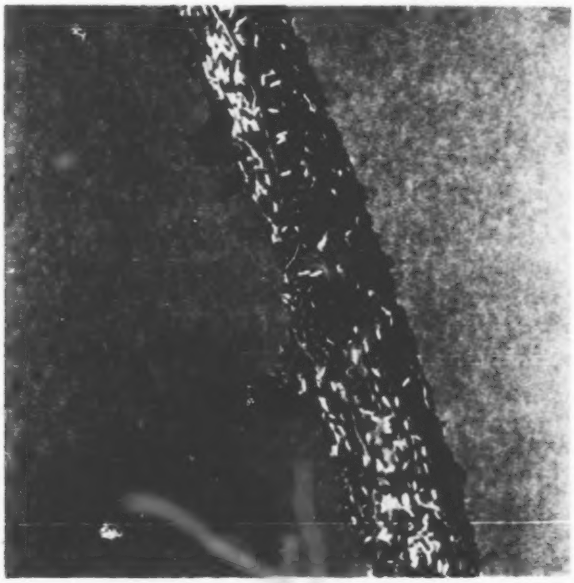


Figure 9.16. The white-bodied males of euonymus scale cover this twig; the females are slightly larger and darker brown.

this is an exaggeration, the pest certainly has a large number of hosts. Figures 9.17 and 9.18 show the beetle and its feeding damage.

Another pest beetle is the black vine weevil, a serious problem on yews, many broadleaf evergreens, and other shrubs. Figure 9.19 shows the adult weevil feeding. It leaves a characteristic notch in the foliage. Although the presence of the black vine weevil can be detected by the feeding pattern of the adult, it is the larvae that cause the damage, feeding on roots.

Many beetle larvae cause damage to trees. Some of the wood borers, like the bronze birch borer, are actually beetle larvae. The bronze birch borer leads to the decline and death of white-barked birches that are planted out of their native range. Symptoms include the sudden wilting and death of aerial portions of the tree (Figure 9.20). Closer examination of the trunk may reveal characteristic lumps (Figure 9.21) and small D-shaped emergence holes.

Lepidoptera

The order Lepidoptera includes butterflies and moths. The larvae of these insects damage trees. The gypsy moth is perhaps the best known in the East where severe outbreaks have led to complete defoliation of entire forests. Other pests in this group include bagworms, tussock moths, white pine tube moth, pine tip moth, Eastern tent caterpillar, mimosa webworm and fall webworm (Figure 9.22).

Some other Lepidoptera larvae are wood borers. Frequently the adult forms are mistaken for wasps since their appearance is very similar. One member of this group is the lilac borer, a serious pest to lilac and ash. Figure 9.23 shows the damage caused by the tunneling and feeding of this pest.

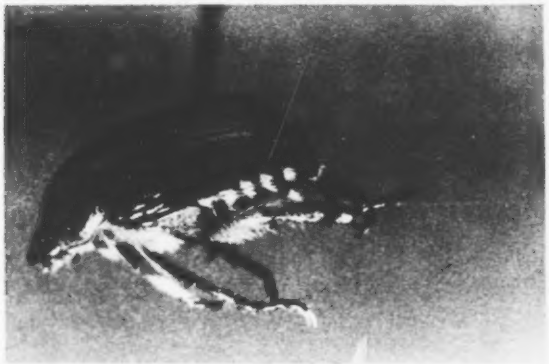


Figure 9.17. The Japanese beetle.

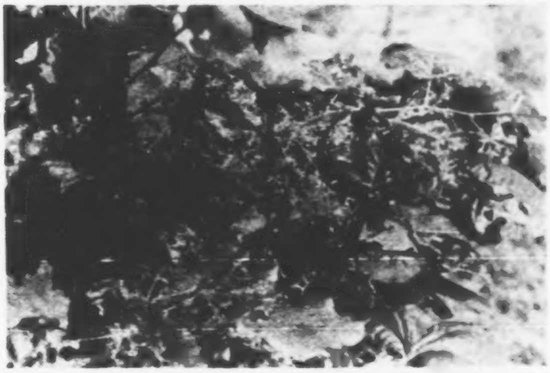


Figure 9.18. Japanese beetle damage to linden

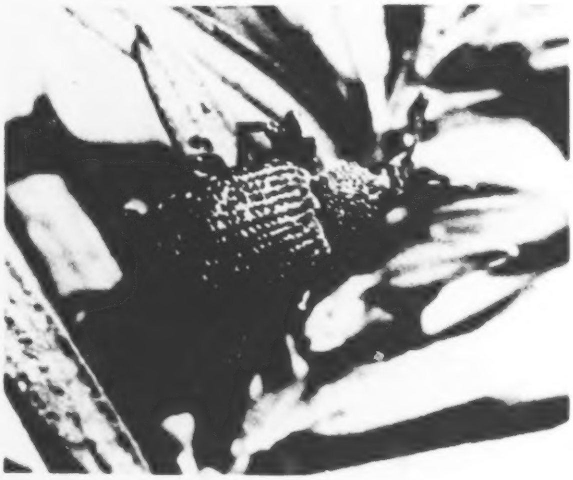


Figure 9.19. Black vine weevil on yew.

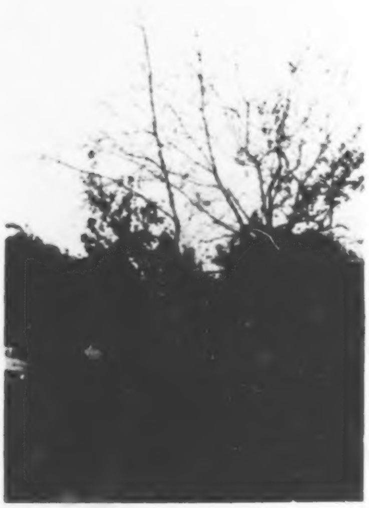


Figure 9.20. Typical decline of birch due to the bronze birch borer.

Diptera

As with many of the orders previously discussed, the larvae of Diptera are the plant pests. Some of these are holly leaf miner, juniper tip midge and honeylocust pod gall midge, among others. Most of these pests do not bring about the death of the plant; they do, however, cause serious cosmetic injury.

Hymenoptera

There are a number of plant pests in the order Hymenoptera, which includes bees, wasps, ants, and sawflies. The birch leaf miner is a sawfly larva which attacks white-barked birches. Other sawflies cause injury to new growth on conifers such as spruce and pine. Figure 9.24 shows red-headed pine sawfly larvae on a pine shoot tip. Some wasps in this order cause galls. Many wasp galls infest different oak species, but few cause serious problems.

INSECT-LIKE PESTS AND SLUGS

A group of insect-like plant pests that are classified in the Class Arachnida rather than the Insecta are the mites. Mites that cause plant injury are either spider mites or gall mites. Feeding by spider mites often causes a bronzing or stippling of the foliage. Gall mites cause various types of small galls. Both types of mites are very small and can usually be identified only with the use of a hand lens.

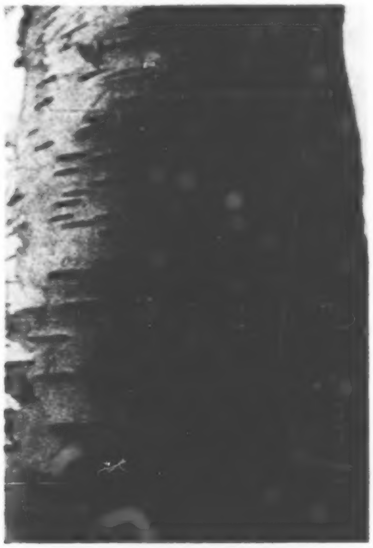


Figure 9.21. This lumpy appearance indicates the feeding of the bronze birch borer.

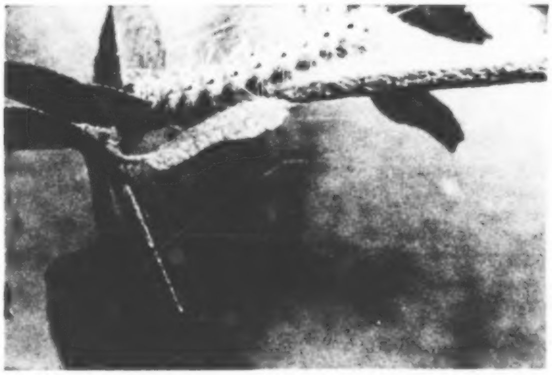


Figure 9.22. Unsightly webs are created by fall webworm on the tips of branches.

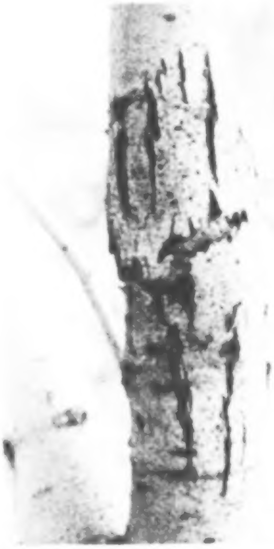


Figure 9.23. Lilac borer damage to ash.

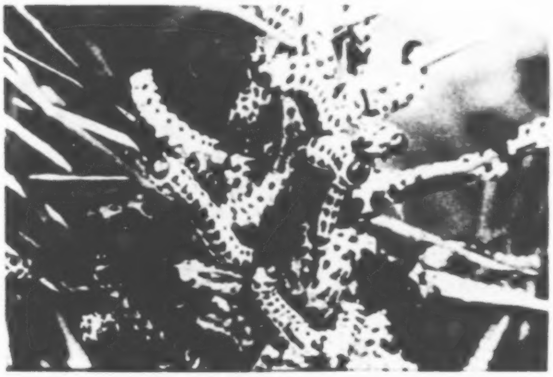


Figure 9.24. Red-headed pine sawfly larvae tend to feed in large groups.

Another plant pest is the slug, a member of the Phylum Mollusca (Figure 9.25). Mollusks are not closely related to insects but are frequently discussed with them because of the similar problems caused. Slugs feed on the foliage of several ground cover plants and leave a slimy trail as they move.

Figure 9.25. The common garden slug, a "snail" without a shell.

OTHER ANIMALS

Many other animals cause injury to plants. Rodents and other small mammals are probably the biggest problem in this category. In winter, when food is scarce, many small animals feed on the bark and cambium of small trees and shrubs. This can girdle and kill the plant. Large animals such as cattle, horses, goats and deer can also be serious pests in nurseries.

A very common bird pest is the yellow-bellied sapsucker. This bird pecks holes in even rows in the trunks of several species of trees. These holes are wounds that provide an entry for canker fungi and certain insects.

ENVIRONMENTAL INJURIES

The category of environmental injuries includes plant disorders that are caused by non-living agents. Physiological disorders, weather-related problems, nutritional disorders, chemical injuries, and mechanical damage fall into this category. In some cases these injuries can be prevented, while in others injury cannot be avoided. Since physiological disorders can upset the balance of health in a tree, treatment that reduces the stress on that tree is important. Frequently insect and disease problems are secondary to environmental disorders.

Weather-related Injuries

Scorch and sunscald are problems related to heat and sun. Sun-scorched foliage will turn brown and die around the margins. The entire plant will be stressed. Sunscald can also heat and kill the cambium of young trees. Shade-loving woodland trees should not be planted in full sun. Plants which tend to scorch, such as sugar maple, buckeye and dogwood, should be planted where reflected light is not severe and moisture is adequate.

Wind can also be very damaging to trees. There are two critical seasons for serious wind damage. In winter, when heavily laden with ice and snow, trees are prone to breakage in storms (Figure 9.26). In late spring, with their newly expanded foliage, trees also break in wind storms. In many parts of the country, spring is also the season for tornadoes.

Besides wind damage, several injuries are associated with winter weather. Frost cracks (Figure 9.27) are a common problem, especially on

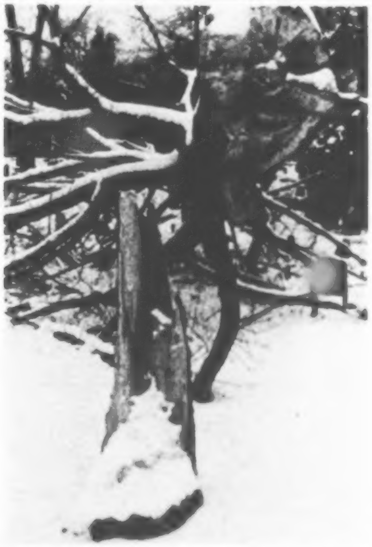


Figure 9.26. Wind and snow often combine to cause tree breakage.

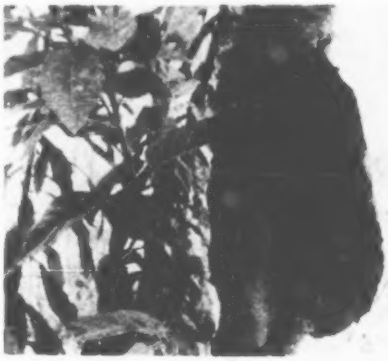


Figure 9.27. Frost cracks are common on maples and sycamores.

young, thin-barked trees. Frost cracks occur primarily on the south or west sides of the trunk. They are caused by extreme temperature fluctuations as the sun heats the bark during the afternoon, followed by rapid cooling during the night.

Other frost injury occurs on succulent growth early in the fall or in the spring when frost hits. A temperature drop below freezing is likely to kill young buds, especially flower buds. Figure 9.28 shows frost damage on new evergreen growth.

Winter burn is another problem — the result of water stress and sunscald during the winter months. The susceptible plants are those that hold their foliage throughout the winter. These plants should be well watered and mulched in the fall.

Another weather-related plant injury is lightning strike. Lightning can cause serious damage and frequently will destroy trees. Symptoms range from bark stripped in a spiral pattern to total shattering of the tree.

Moisture stress is a common problem with urban trees. Inadequate moisture may lead to sunscald, wilting and eventually death. Moisture stress frequently predisposes the plant to other problems. Excess moisture can be as serious as drought. Certain plants such as yews and broadleaf evergreens are very sensitive to poor drainage and may be killed outright.

Although most weather-related problems are unexpected, some are avoidable. The best measure of prevention is planning. Plant only stress-tolerant trees in an environment which is stressful.

Soil Stress

Numerous plant disorders are related to soil stress. Included are physical injuries caused by digging and compaction of soil in the root zone. Also, as previously discussed, drainage problems will cause water stress. Some soils have such a rocky or high clay content that they are strictly limited as to the species that will grow in the area.

Soil pH is a measurement of the acidity or alkalinity of the soil. This is important since it can affect the availability to plants of essential elements and micronutrients. Two common deficiencies, iron and manganese, are related to high soil pH. The alkalinity of the soil causes these micronutrients to be "tied up" in a form unavailable to the plant. Iron chlorosis in pin oak, for example, is a common problem in alkaline soils. Chlorotic pin oak foliage is shown in Figure 9.29. Notice also the necrotic flecking (small dead spots). Manganese deficiency is a similar problem on maples, hackberry and spruce. The typical symptom on red maple is intervenal chlorosis (Figure 9.30).

Pollution Damage

As the urban population increases, air pollution damage to plants becomes a more pressing problem. Researchers are looking for plants that

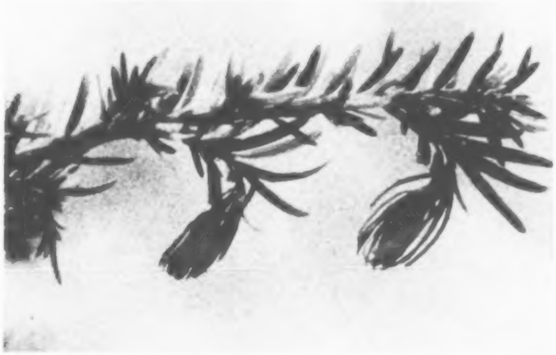


Figure 9.28. Early growth was killed on this evergreen by an early spring frost.

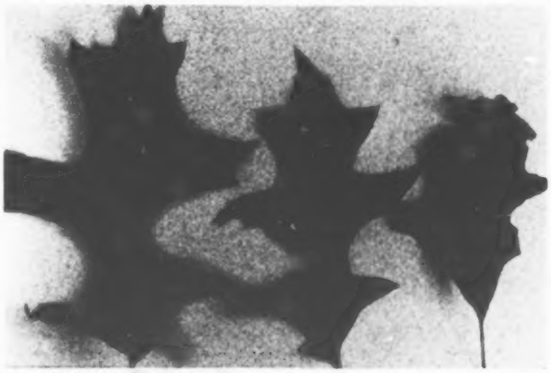


Figure 9.29. Iron chlorosis is a limiting factor in the use of pin oak in some areas.

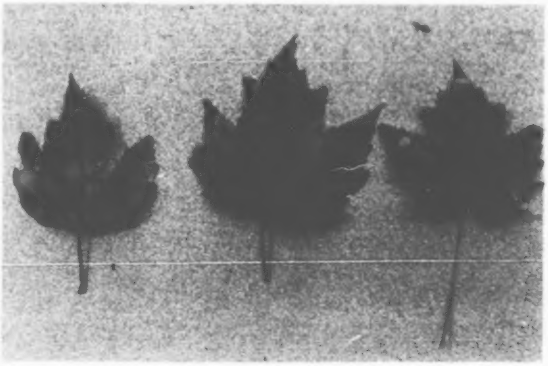


Figure 9.30. Manganese deficiency in red maple.

can withstand the stresses of a polluted city environment. There are several urban pollutants which can cause plant injury: sulfur dioxide (SO_2), ozone (O_3), peroxyacetyl nitrates (PAN), and chlorine and fluorine gases. Symptoms of air pollution injury are often similar to symptoms of other disorders. This makes diagnosis difficult. Two of the symptoms are marginal discoloration and defoliation. Intervenal bleaching is also common. When ozone levels are high, susceptible plants can be protected with a spraying of ascorbic acid.

Chemical Injury

The primary sources of chemical injury to plants are pesticides, which include herbicides, insecticides and fungicides. If applied correctly, insecticides and fungicides are rarely a problem to plants. Incorrect application may lead to marginal browning or tip dieback of the plant. Herbicide toxicity is a more common problem. With the wide range of chemicals being used, symptoms are varied. Intervenal chlorosis occurs after use of some herbicides. Epinasty and parallel venation are symptomatic of synthetic auxins such as 2,4-D and Dicamba (Figures 9.31 and 9.32).

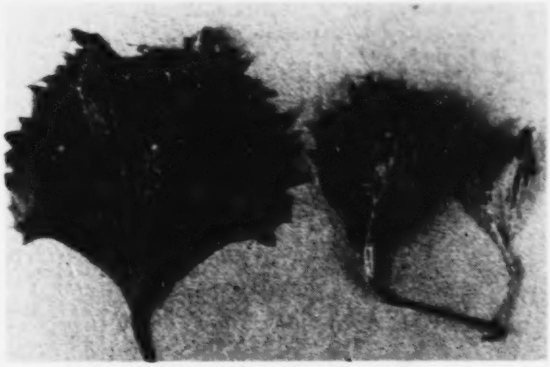


Figure 9.31. An example of 2,4-D injury

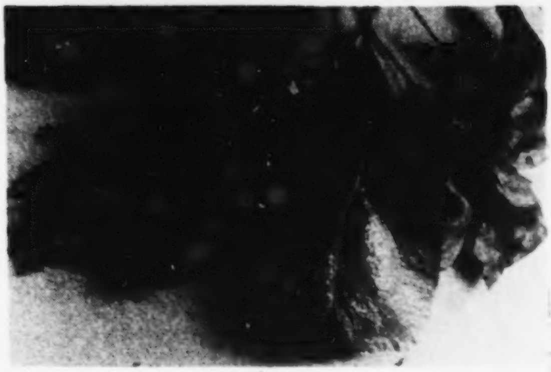


Figure 9.32. Epinasty or cupping of the leaves is another symptom of 2,4-D injury.

Another type of chemical injury results from the presence of high levels of soluble salts in the soil. These salts may have come from road salt used for de-icing or from overfertilization or chemical dumping. In any case, they cause water to move out of the plant. The results are wilting, scorch or even death of the plant.

Mechanical Injury

The sources of mechanical injury are too numerous to discuss them all. One thing common to many is the human element. Construction damage is a very common type of mechanical injury. Another well-known problem is "lawn mower blight," the injury to tree trunks from repeated bumping with the lawn mower (Figure 9.33). Other sources of injury are vandalism and children's play. Unfortunately many people do not respect trees in the landscape.

Girdling is another major type of mechanical injury. Most girdling is the result of improper planting technique. Girdling roots can often be avoided if container-grown plants have their roots cut and separated at planting time. Plastic twine tied around balled and burlapped plants can girdle the plant if not cut (Figure 9.34). Wire used in staking and guying trees also may girdle the plant if not removed after one year.

There are many stresses and disorders which can affect the health of a tree. Frequently prevention and treatment are a matter of basic knowledge and common sense. Remember the old

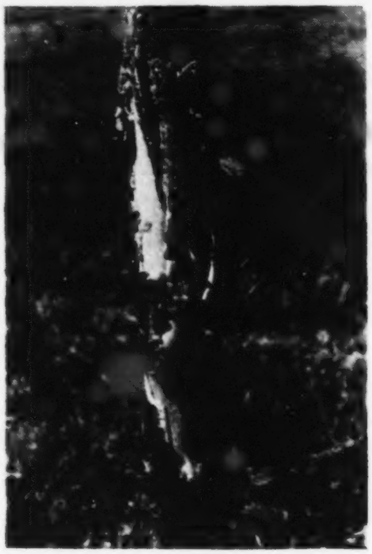


Figure 9.33. Treatment for mechanical injury includes removal of loose bark. Prevention of injury from close mowing can include mulching around the tree.

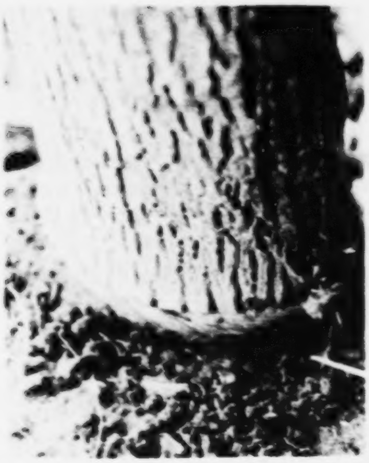


Figure 9.34. Wire and plastic twine often are the cause of girdling in young trees.

adage, "An ounce of prevention is worth a pound of cure!"

Treatment of Tree Health Problems

To some people, treating a tree disorder automatically means spraying the tree with a chemical. In fact, chemical application is frequently *not* the best control method. The first step is to diagnose the problem and consider all the contributing factors. As previously discussed, tree health is a delicate balance of the species with its environment.

The modern approach to maintaining tree health involves Integrated Pest Management (IPM). The word "pest" in this phrase may refer to problems other than insects. The basic idea of IPM is to use and integrate various prevention and control treatments to maintain the health of the plant.

A good start in obtaining a healthy tree is to choose the right plant for the environment. Many factors must be considered, such as sunlight, rainfall, drainage, soil type and pH, and temperature extremes. All these environmental factors and others must be taken into account when choosing a tree for a given situation. Other important considerations involve the characteristics of the plant — height and spread at maturity, flowers, fruit, foliage, and many others. One of the most important items is selection of cultivars that are resistant to common insects and diseases.

Since the arborist usually must deal with plants already established, it is not always possible to select an "ideal" plant. Frequently treatment must center around altering the environment (for example, by installing an aeration system) to improve the health of the tree. In many cases it is best to remove the ailing plant and replace it with one that is more suitable.

Another key part of maintaining tree health is proper pruning and sanitation. As discussed in Chapter 5, pruning can remove dead and diseased branches and can help improve air circulation and sunlight penetration. Good sanitation practices involve sterilizing tools that may spread disease, disposal of diseased limbs, and raking fallen leaves and twigs that may harbor disease inoculum.

If the tree problem involves an injury rather than a disease, the treatment is based on reparation. Broken limbs should be carefully pruned. Loose or shredded bark should be removed. If necessary, the edges should be traced with a sharp knife, leaving a clean edge of bark around the exposed inner wood. Wound dressings are not necessary, but a thin coat of an asphalt-based paint may improve appearance.

Another aspect of Integrated Pest Management is finding alternate insect and disease control measures. Several examples are currently being studied and, in some cases, implemented. Dormant oils which kill certain insects without harming trees are a good alternative to insecticides. The use of natural predators and parasites as control measures may be effective. For example, the ladybird beetle feeds on certain scale insects and may be used to keep down their populations. Several bacterial diseases of insects have been found to help control pests such as the Japanese beetle and certain caterpillars. Insect pheromones, or hormones, are being used to trap specific insects, disrupt their mating habits, or time pesticide applications.

Many plant disorders are kept under control with the use of "chemicals," a broad term which includes fertilizers, insecticides, miticides, fungicides, herbicides and anti-dessicants. Many experts recommend that chemical treatments be the *last* line of defense. Some pests, however, cannot be effectively controlled without chemicals. It is important to consider the principles of IPM and employ a variety of treatment measures whenever possible.

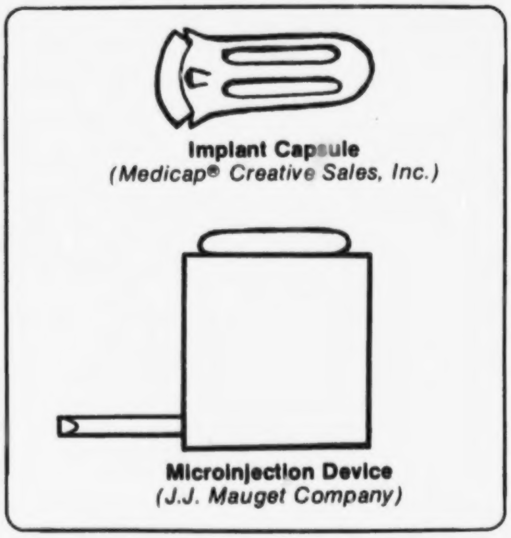
IMPLANTS AND INJECTIONS

Implants and injections are a fairly recent innovation in tree care. Both are methods of applying chemicals *systemically* to the tree. The three types of chemicals currently in use are fertilizers, systemic fungicides and systemic insecticides. The intent is to get the chemical into the vascular system of the tree where it will be carried throughout the plant. Micronutrients can be applied in this manner to treat deficiencies. A systemic fungicide can provide a protective barrier against infection or retard fungal growth. Systemic insecticides kill insect pests as they feed.

There are several potential problems associated with the use of implants and injections. Improper placement may cause wounds, decay, or toxicity. Arborists should be properly trained and instructed before attempting to apply these treatments. Timing and placement are the important factors. Commercial products recommend the best time of year for application. Some distributors hold workshops to instruct tree care professionals in the proper use of their products.

Proper techniques in application and placement are vital. Most implants and injections are applied at the base of the tree near or at the root buttress or flare. The smaller the wound for implant or injection, the better. Some methods require drilling a small hole, while others come with insertion tools. As a rule, a clean hole will allow better uptake of the material with less damage around the point of insertion. Figure 9.35 illustrates some types of products available.

Another method of systemic fungicide application currently being studied is high pressure injection for use on American elms. It is hoped that this method will help prevent the spread of Dutch elm disease to the remaining valuable elms. As with implants and microinjection, the goal is to get the fungicide to all parts of the tree internally. The difference is the use of pressure to force the chemical throughout the tree. This method is not currently widely employed by commercial arborists.



Implant Capsule
(Medicap® Creative Sales, Inc.)

Microinjection Device
(J.J. Mauget Company)

Figure 9.35. Implant and microinjection device.

SPRAY OPERATIONS

Tree spraying is one of the most visible pesticide applications. It is very important that tree care professionals operate carefully and within the law. Applicators must follow all federal, state and local regulations. Licensing or certification is at the state level. Pesticide application supervisors must be certified applicators or under the direct supervision of a certified commercial applicator.

Pesticide Labels

The label on a pesticide container bears very important, valuable information. The label lists what pests the chemical will control and on what plants it can be used. Chemicals must not be used for anything that is not specified on the label. The label gives the trade name of the product, the chemical name, form (wettable powder, liquid, etc.), warnings or cautions, and other important information. Chemicals should always be stored in their original, labeled containers in a well-ventilated, secure location.

Equipment

Trucks carrying pesticide application units must be of sufficient capacity to carry the load of the full spray tank and equipment (Figure 9.36). The truck should have locked boxes for carrying pesticide concentrates. Each truck should be equipped with the necessary personal protective gear for the applicators: jackets, pants, head gear, footwear, gloves, respirators, eye protection, and a first-aid kit. The truck should be clearly lettered (with 3-inch letters) with the company name and the city and state in which the company is located.

Hydraulic sprayers used in tree care operations for spraying trees over 60 feet in height should have a minimum pump capacity of 50 gallons per minute. The tank should have a capacity of not less

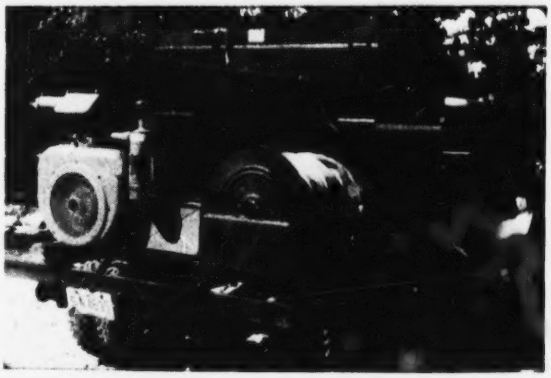


Figure 9.36. This truck is fully outfitted for pesticide application to trees.

than 400 gallons and should be equipped with either mechanical or jet agitation. The hoses should have a minimum burst pressure of no less than twice the operating pressure of the pump.

The nozzle or gun should have a capacity sufficient to deliver the gallon-per-minute rating of the pump. Most nozzles are adjustable from straight stream, to a fan, to shut-off. Figure 9.37 shows a pesticide applicator wearing protective gear and holding the spray gun.

Sprayer Calibration

The applicator has the responsibility to minimize drift and exposure to non-targets or things not requiring spraying. Good application techniques alone are not enough. Correct equipment must be used. Proper calibration is essential. In calibrating the sprayer, the optimum combination of pressure, nozzle size and hose is selected to insure complete coverage without waste and with minimal drift.

Many factors influence the amount of drift: air movement, temperature, humidity, nozzle type, spray pressure and droplet size. The smaller the droplet size, the greater the amount and distance of drift. Ideally, the droplets should be as large as possible, maintaining complete coverage (Figure 9.38). If operating pressure is increased with the intent of increasing the height of spray, droplet size will decrease and drift could become a problem.

Sprayer calibration is based on choosing a nozzle disk size and then calculating the necessary operating pressure for the pump. With the nozzle open, the desired pressure at the gun is 400 pounds per square inch (psi). Since some pressure is lost as the liquid flows through the hose and couplings, the operating pressure at the pump will have to be set at a level somewhat higher than 400 psi. The goal in calibration is to calculate the pressure loss in the system.

Figure 9.37. A pesticide applicator with a spray "gun"

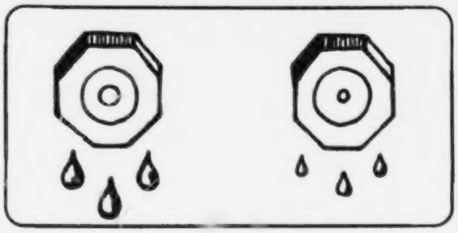


Figure 9.38. Choose a nozzle disk that will maximize droplet size and still allow adequate spray height.

First, determine the spray height that will be necessary. Use the manufacturer's table (Table 9.1) to choose an appropriate disk size.

The amount of pressure loss is affected by several factors; volume of spray, diameter and length of hose, and number of couplings. The pressure loss in a small diameter hose will be greater than that in a larger diameter hose (Figure 9.39). Frequently tree sprayers are equipped with 100 feet of 1-inch-in-diameter hose near the pump, plus 200 feet of ¾-inch hose to the nozzle. Charts

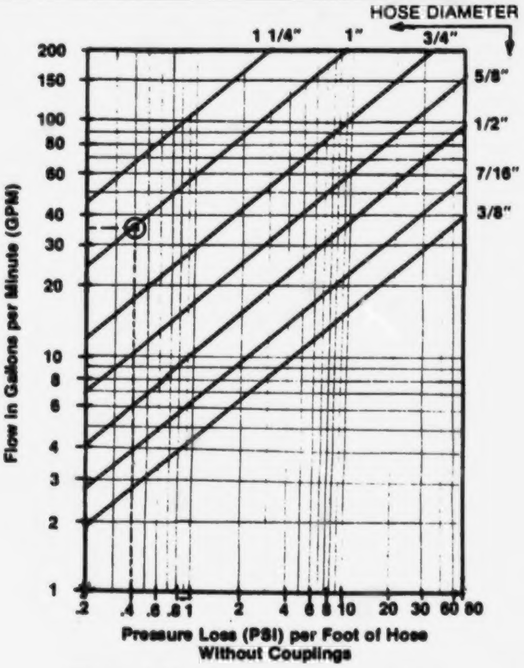


Figure 9.39. Pressure loss in hose

TABLE 9.1

RECOMMENDED TIPS ON SHADE TREE SPRAYING*

Pump GPM	Pump PSI	Hose Size	Gun & Spray	Nozzle PSI	Height Trees to Spray	To Obtain Maximum Height
60 50	600-800# w/200' of 3/4" plastic hose	1/4"	785 equipped with special kit #22	350 to 450	65' to 110"	Use 785 Gun equipped with 5254037 kit installed.
35	600# w/200' plastic hose	5/8"	785 & #16	350 to 450	50' to 80'	Use 785 Gun equipped with 5254037 kit
25	600-700# w/200' hose	5/8"	785 & #14	350 to 450	40' to 65'	Note: Pressure and water volume are the factors that allow us to reach our target. For water particles to carry, they must have mass so there are limits to the maximum pressure used to increase the throw or carry of a water stream. In shade tree spraying, relatively large droplets are necessary to keep outside wind from dissipating or spreading the water stream. Hence, our recommendation of NOZZLE PSI.
20	400-500# w/100' hose	5/8"	785 & #14	300 to 400	35' to 50'	
10	400# w/100' hose	1/2"	785 & #10	300 to 350	20' to 35'	
5	400# w/100' hose	3/8"	57 & #7	250 to 300	10' to 20'	
3	400# w/100' hose	3/8"	57 & #6	300 to 350	10' to 20'	
5	60# w/15' hose	5/16"	45 & #10	50 to 60	10' to 15'	

REMEMBER:

1. Always use a large enough hose with nozzle disk to permit using as much of the pump capacity as possible.
2. Plastic hose has less friction loss than rubber.

*Courtesy of FMC Corporation

are available to give pressure loss in the hose if the flow rate (gallons per minute) and hose size are known (Figure 9.39). The pressure loss is given per foot of hose. The pressure loss per foot must be multiplied by the length of hose. In addition, 10% of the loss for 50 feet must be added for each set of couplings. (See the sample in Table 9.2.)

Table 9.2 Sample calibration

desired height of spray = 60 feet

300 feet of 1" hose

3 sets of couplings

nozzle size #16 (from Table 9.1) flow = 35 gpm ⬆

➡ pressure loss in hose = 0.4 psi/foot (from Fig. 9.39)

- 0.4 psi/ft. x 300 ft. = 120 psi

pressure loss from couplings:

- 0.4 psi/ft. x 50 ft. x 0.10 = 2 psi/coupling
- 2 psi x 3 = 6 psi for 3 couplings

total pressure loss = 120 psi (hose) + 6 psi (coupling) = 126 psi

pressure setting at pump = 400 psi (operating pressure at gun) + 126 psi (pressure loss) = 526 psi

Pesticide Application

Proper pesticide application means using the right material at the right time, obtaining thorough coverage, and avoiding non-target exposure and drift. Pesticide applicators should keep a detailed, accurate log recording the following: date and time, chemical used, plants sprayed, target pest(s), weather conditions, and any additional notes. This log will prove valuable if any questions arise in the future.

When mixing chemicals, remember that you are handling concentrated materials. Be sure to wear the necessary protective gear (Figure 9.40). Avoid dust or liquid splashing in the face. Rinse the empty container into the spray tank before disposing of it according to regulations. Pesticide containers must always be disposed of according to the label and existing laws to prevent contamination of the environment.

Before beginning to spray, check all equipment carefully. Be sure that each piece is functioning properly and that there are no leaks.

Pesticides must not be applied unless weather conditions are appropriate. There should be little or no wind. Some labels specify temperature ranges in which the chemicals should be applied. Generally, early morning is the best time for application, when weather conditions are most often cool and calm.

There are a number of points to keep in mind when spraying landscape plants.

- Comply with all federal, state and local regulations.
- Treat only designated plants.
- Position yourself as applicator so that the drift is carried toward the tree and away from you and non-target areas (Figure 9.41).
- Do not spray if there is undue risk to people, food, animals, beehives or any other sensitive areas.
- Apply the pesticide so that coverage is thorough without drenching (Figure 9.42). Check for leaf movement when spraying the tops of trees. Spray both upper and lower leaf surfaces.
- Start at the top of the tree and work down, gradually decreasing volume toward the bottom of the tree.
- When treating foundation plants, spray away from the building.
- Spray from the outer perimeter of the property inward whenever possible to avoid application to neighboring properties.

Figure 9.40. Wear protective gear when mixing chemicals.

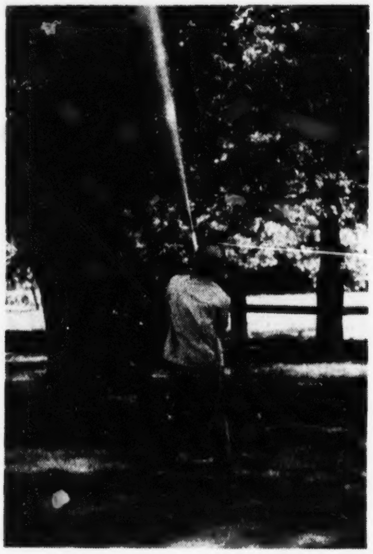


Figure 9.41. The applicator should be positioned to avoid drift.

Figure 9.42. The goal is thorough, even coverage without drenching.

CHAPTER 10

Other Tree Care Operations

Objectives

The purpose of this chapter is to acquaint the student with a variety of tree care operations other than pruning and removal.

1. Learn the techniques used in planting and transplanting trees.
2. Become familiar with the specifications for guying and staking trees.
3. Know and understand the methods of fertilizing trees.
4. Learn the techniques involved in cabling and bracing.
5. Gain familiarity with methods used to protect trees from lightning damage and construction injury.

Planting Trees

Planting a tree is not quite so simple as digging a hole in the ground and sticking in a tree. There are a few rules and specifications that should be followed to help insure that the tree will survive.

The first step in planting a tree is hole preparation (Figure 10.1). There is an old expression that goes, "Never put a ten-dollar tree in a five-dollar hole." The point is that an expensive tree could be lost if proper care is not taken in digging the hole. Generally a 6- to 12-inch gap should be left between the edge of the root ball and the edge of the hole in all directions around the ball. The depth of the hole, however, should not be greater than necessary, since the tree will tend to sink through soft backfill dirt when water is applied.

Figure 10.1. Dig the hole larger than the root mass of the tree.

Trees may be purchased in one of three forms: bareroot, balled and burlapped, or container-grown. Figure 10.2 shows a bareroot tree. Before planting, the roots of a bareroot tree should be soaked in a tub of water for at least 30 minutes. When planting the tree, first remove all dead or badly damaged roots. Then distribute the remaining roots as evenly as possible in the hole (Figure 10.3).

A tree that has been balled and burlapped may be somewhat easier to plant since the root mass is contained in the soil. Also, burlap is biodegradable; it does not have to be removed before planting. Avoid using non-biodegradable materials such as plastic or nylon. Jute twine used to tie up the ball will also decay in the soil. If the twine is tied tightly around the tree trunk, cut it to avoid girdling. Figure 10.4 shows a balled and burlapped tree that is laced with twine. Larger tree balls are sometimes enclosed in a wire basket (Figure 10.5). The basket can be left on to facilitate planting. After the tree is in the hole, the wires can be snipped and folded back.

Container-grown plants should be removed from the container (Figure 10.6) unless it is a biodegradable peat container. It may be necessary

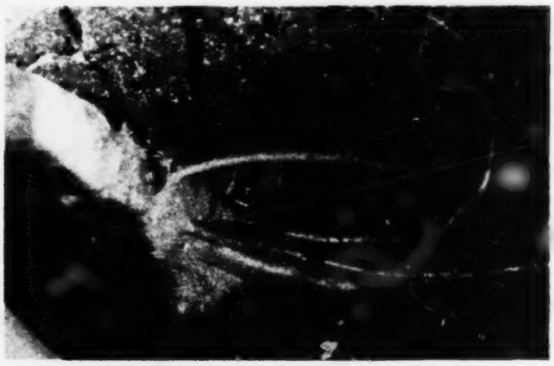


Figure 10.2. A well-branched, viable root system

Figure 10.3. Distribute the roots evenly in the hole.

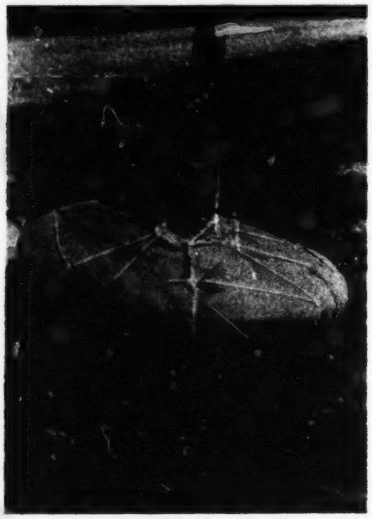


Figure 10.4. A neatly laced, balled and burlapped tree

Figure 10.5. A wire basket helps to keep the root ball intact on larger trees.

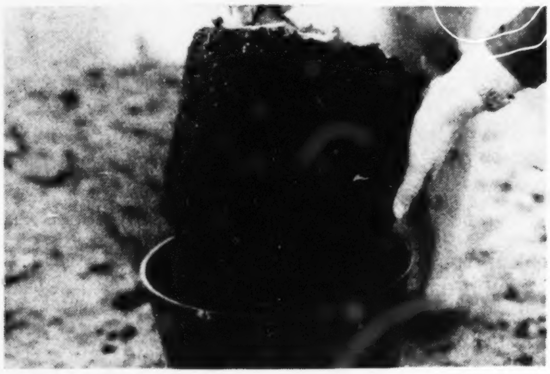


Figure 10.6. Carefully slide the plant out of the container before planting.

to cut through the root mass to eliminate twisted or girdling roots (Figure 10.7).

Planting depth may vary slightly with drainage and rainfall. In heavy clay soils trees are generally planted 4 to 6 inches more shallow than grown in the nursery. In dry or sandy areas plants may be placed in the hole at or slightly lower than ground level. Either way, the bottom of the hole should be firm and flat to avoid sinking.

There is some argument concerning backfill in the hole. Research suggests that if the hole is filled with rich, loose soil, the roots will grow rapidly until they reach the harder, undisturbed soil. Then the roots may begin to grow around the hole. To avoid this, roughening the sides of the hole should eliminate the smooth, glazing effect. Peat moss or other amendments may be added to the backfill soil to improve texture (Figure 10.8). It is often helpful to apply water when the hole is half filled to help distribute the soil around the roots. The soil is then lightly tamped around the roots.

After the tree is planted, watering should be completed. A good, slow soaking is best. Figure 10.9 illustrates how a saucer of soil built around the plant can keep the water around the root zone. After watering, a 3- to 5-inch layer of mulch should be applied around the tree. The mulch will help to retain moisture, reduce weeds, and keep away lawn mowers. Mulch also helps unify landscape plantings and adds a decorative touch.

Guying, Staking and Tree Wraps

It is not usually necessary to stake or guy small trees. A well-tamped backfill may be sufficient to keep the tree upright. If the tree is to be staked, the stakes should extend about two-thirds the height of the tree. Figure 10.10 shows a properly staked tree. The stakes should not penetrate the root ball.

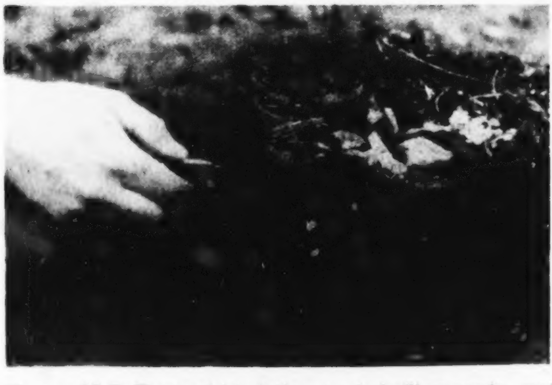


Figure 10.7. To avoid twisting and girdling roots, make several vertical slices with a knife through the outer layer of roots and medium.

Figure 10.8. Peat is often added to the backfill soil to loosen poor clay texture and help retain water.

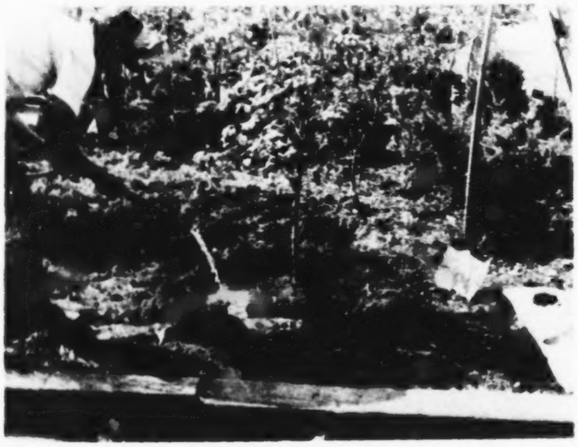


Figure 10.9. The saucer of earth aids in water collection.

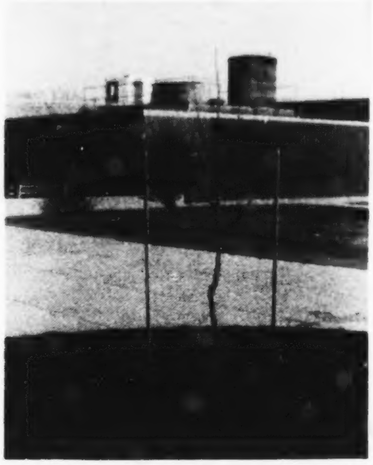


Figure 10.10. Two vertically placed stakes are recommended in staking a tree.

Sections of rubber tubing will protect the tree where the guy wire is passed around the trunk (Figure 10.11). Stakes and wires should be removed after one year. Staking wires are a frequent cause of girdling and death in young trees.

Sometimes it is desirable to use tree wrap on young, newly planted trees. The purpose of tree wrap is to help protect the tree from sunscald. The wrap should be applied from the bottom, working up to allow for water runoff. Twine is used to secure the wrap and is tied from the top down with a series of half-hitch knots (Figure 10.12).

Transplanting Trees

The basic rules for planting also apply for transplanting trees. Transplanting is often done on a larger scale, however. Large equipment such as a mechanical tree spade may be used (Figure 10.13). The planting hole might be dug with a backhoe, earth auger or tree spade. Staking large trees is often not practical. Guying is used to secure trees greater than 3 inches caliper (Figure 10.14). Usually three guy wires are used and are spaced equally around the tree.

In tree transplanting, timing is very important. Midsummer is not a good time to transplant trees since water stress will reduce possibilities of success. It is best to plant and transplant trees when they are dormant. Early spring and late fall are good times as long as the ground is not frozen.

Planting time may be a good time for corrective and formative pruning. The usual rules for pruning apply. Some experts recommend, when

Figure 10.11. Proper positioning of the guy wires around the main trunk

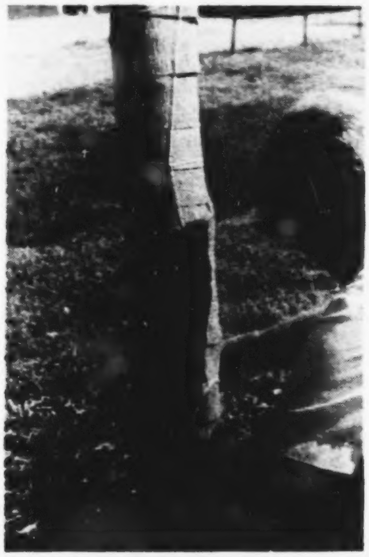


Figure 10.12. Secure the tree wrap carefully from the top down.

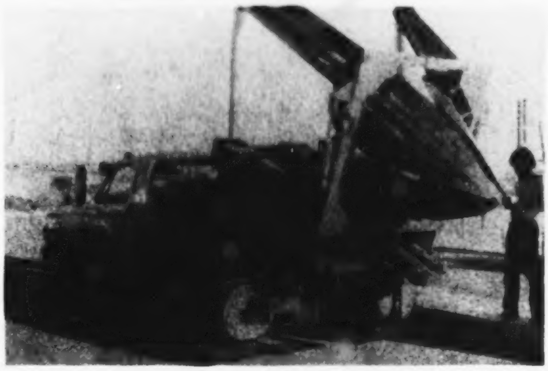


Figure 10.13. Transplanting of landscape-sized trees is often done with a truck-mounted mechanical spade.

Figure 10.14. Note the use of turnbuckles on the guy wires to keep the tree tightly anchored.

transplanting, that one-third of the crown be thinned. The central leader should not be pruned back.

Fertilization

A tree that is growing in a forest or natural area is naturally fertilized by rich, loamy, organic soils. However, trees in a landscape setting may be growing in suboptimal soils that lack sufficient quantities of essential minerals. For this reason it is often quite beneficial to fertilize landscape and urban trees.

Trees should be fertilized every two or three years for best results. Timing is fairly important. Fertilizer can be applied in late fall starting in October and through December or until the ground is frozen. Trees can also be fertilized in the spring any time from March until June. Late-summer fertilization is not a good idea, as it may induce vigorous new growth which is prone to winter injury.

There are many types of fertilizers. A **complete** fertilizer contains nitrogen, phosphorus and potassium. For trees a complete fertilizer that is high in nitrogen is recommended. The **fertilizer analysis** gives the percentage of each: nitrogen, phosphorus and potassium. For example, a fertilizer bag with an analysis of 10-5-5 contains 10% nitrogen, 5% phosphorus (expressed as P_2O_5 equivalent), and 5% potassium (expressed as K_2O equivalent). A 100-pound bag of this fertilizer would contain 10 pounds of actual nitrogen. A good tree fertilizer should have a 2-1-1 or 4-1-2 ratio. Other possible analyses are 24-8-8, 10-6-4, and 24-8-16.

The nitrogen in fertilizer may be water soluble and may leach from the soil after watering or rainfall. For this reason, at least half of the nitrogen should be in an organic or slow-release form. Two slow-release forms of nitrogen are sulfur-coated urea and urea formaldehyde.

Three basic methods of applying fertilizer to trees include surface or broadcast application, liquid soil injection, and drill hole application. Of the three, the surface application is certainly the easiest. This involves the broadcast spreading of fertilizer (usually granular) over the ground where the tree is located. Since the tree roots may extend far beyond the drip line of the tree, the application should be quite widespread. With the majority of the fibrous "feeder roots" located in the upper 6 inches of soil, this method is usually quite effective. But there are two disadvantages to surface application. If phosphorus is a limiting factor, surface application may not be effective, because phosphorus will not penetrate the soil readily. Also, while the lawn may benefit from the high nitrogen fertilizer, it will also compete for it. The levels of nitrogen applied cannot be raised much without "burning" the lawn, so applications have to be more frequent.

Liquid soil injection is a technique employed by many arborists (Figure 10.15). It involves the use of a thin tube or probe which is pointed and perforated at the end. The probe is attached to a hose and sprayer rig (Figure 10.16). The liquid

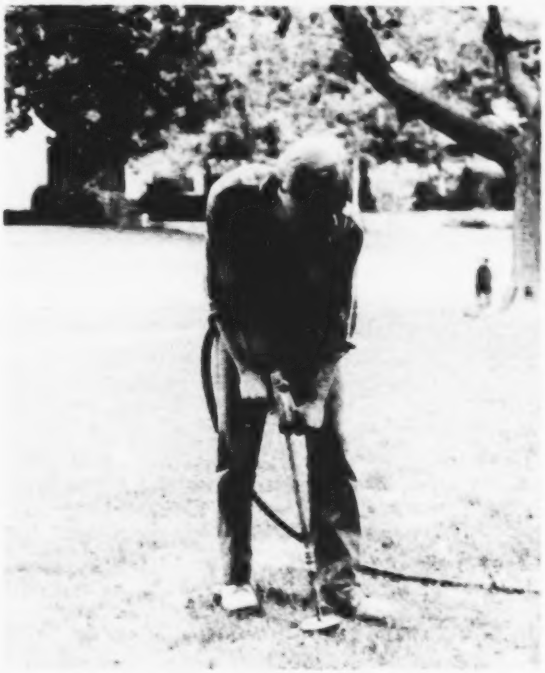


Figure 10.15. Liquid fertilizer is injected into the root zone of the tree.

Figure 10.16. Experienced arborists set up for application of fertilizer.

fertilizer is injected under pressure to a depth of 10 to 18 inches below the soil surface. The liquid spreads through the soil around the hole. This method obviously requires expensive equipment, but many arborists do have it. One disadvantage of this method is that patches of dark, vigorous growth may result in the lawn. Such a condition can be remedied by an additional broadcast application, however.

The drill hole method of application is similar to the injection technique. Holes are drilled into the soil, and granular fertilizer is placed in the holes. It is better to drill than to poke or punch holes in the soil, since the latter may cause compaction and glazing of the soil around the holes and result in limited penetration. The drill hole method is the most time-consuming one, but is thought to help aerate the soil around the roots. In fact, in compacted areas, sometimes holes are drilled and filled with pea gravel or other amendments to help provide oxygen to the roots. Drill hole fertilization may also create dark patches in the lawn.

In both drill hole and soil injection methods the fertilizer is applied in concentric circles around the tree (Figure 10.17). For liquid soil injection the holes are generally on 2- to 3-foot centers. For drill hole application the spacing is usually 18 to 24 inches. For large trees the holes need not be any closer than 3 to 4 feet from the trunk. With both these methods, as with the broadcast method, application should extend beyond the drip line of the tree in order to cover the feeder roots that often extend further out. Frequently the extent of fertilizer application is limited by the size of the yard in which the tree is located.

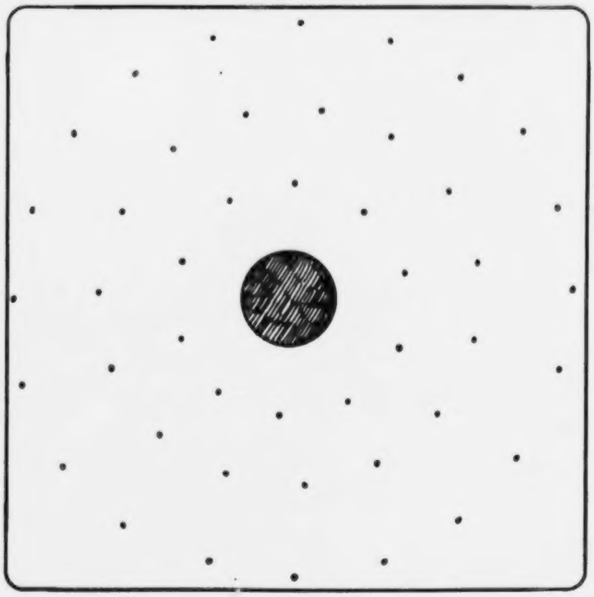


Figure 10.17. Holes are drilled in concentric circles around the trunk of the tree.

The rate of application depends upon the method of application. For drill hole or liquid soil injection the recommended rate is about 5 pounds of actual nitrogen per 1000 square feet of soil surface under the tree. For example, say the fertilizer to be used has an analysis of 20-5-10. In an area calculated to be about 1000 square feet, one would have to apply 25 pounds of fertilizer. For broadcast application on lawns, 5 pounds of actual nitrogen would be excessive. Two pounds of nitrogen per 1000 square feet is more practical, but two or three applications per year would be required.

Cabling and Bracing

Cabling and bracing are methods of installing hardware to help maintain structural strength in trees. Proper cabling and bracing can help prolong the health and safety of a tree. The need for cabling or bracing may be due to split or decayed crotches, tight V-shaped crotches, or inherent dangers from weak-wooded trees. Maple, ash and elm are some of the species that frequently require cabling or bracing.

Cabling is a means of connecting two or more limbs to help support or strengthen a tree. Figure 10.18 shows much of the hardware used in cabling. It is important to use equipment that is strong enough for the loads being applied. The cable itself is usually 7-strand galvanized wire that ranges in diameter from 3/16 to 1/2 inch. The smaller cable can be used for limbs 3 to 4 inches in diameter. The 1/2-inch cable is used for limbs 12 to 24 inches in diameter. Intermediate cable sizes include 1/4-, 5/16-, and 3/8-inch diameters. For limbs 10 to 12 inches in diameter, lag hooks can be used (Figure 10.19). Lag hooks come threaded

Figure 10.18. Proper cabling requires use of the right equipment.

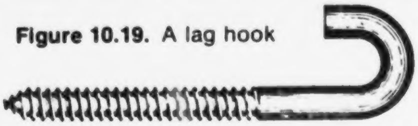


Figure 10.19. A lag hook

Figure 10.20. A nut eye bolt

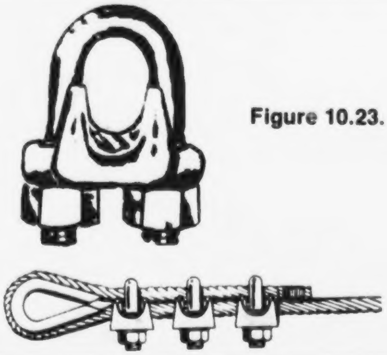


Figure 10.23. Clips

right- and left-handed (one to be used at each end of the cable) and range in size from 1/4 to 5/8 inch. For limbs greater than 12 inches in diameter, nut eye bolts should be used (Figure 10.20).

For lag installation, first drill into solid wood a hole that is 1/16 inch smaller than the diameter of the lag (Figure 10.21). More leverage is obtained by placing the cable high above the crotch, but there is a trade-off in size and strength of the limbs. If more than one lag is placed in a limb, the lags should be at least one foot apart and not in the same vertical line. The lags should not be screwed in so tightly that the hook touches the bark. Lags at opposite cable ends should line up with each other.

One end of the cable can be wrapped around the thimble and closed before installation. There are three methods of closing the cable upon itself. 1) The cable can be spliced by unwrapping the strands and individually wrapping them around the cable with pliers (Figure 10.22). 2) U-bolts or clips (Figure 10.23) can be used to hold the cable tightly against itself. 3) Many arborists are now using twisted cable wrap (Figure 10.24). This device wraps around the cable and grips it firmly. Cable wraps are easy to install and can be used effectively when working in the tree. After the required length of cable has been measured, the second cable closure is often done in the tree (Figure 10.25). The limbs being cabled should be brought closer together using ropes or a *come-along* so that after installation, the cable will be taut (Figure 10.26). But the limbs should not be brought so close that undue stress results on both hardware and tree.

Figure 10.27 shows use of a simple or direct cable. Multiple cables too are often installed.

(continued on page 109)

Figure 10.21. The use of electric drills can be impractical when working in a tree, so holes must be drilled manually.

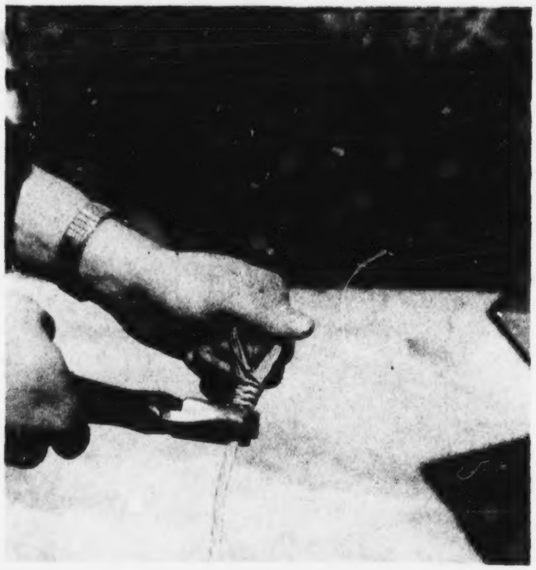


Figure 10.22. Pliers are used to wrap the strands of the dead end cable.

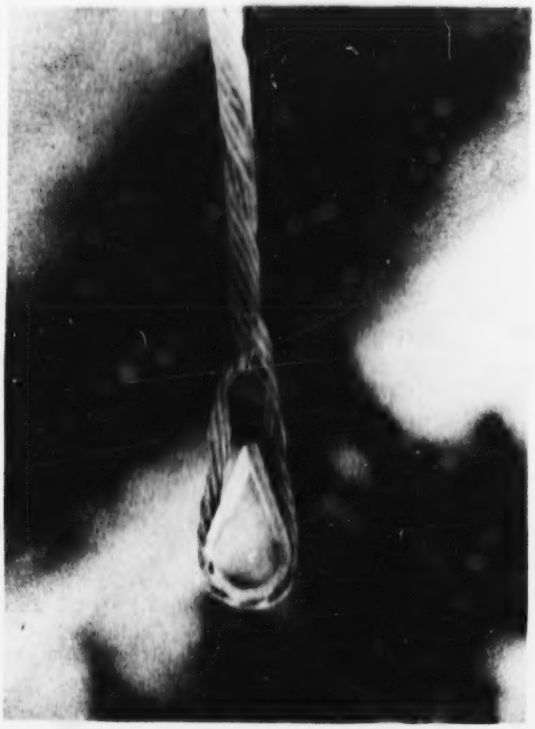


Figure 10.24. Twisted cable wire

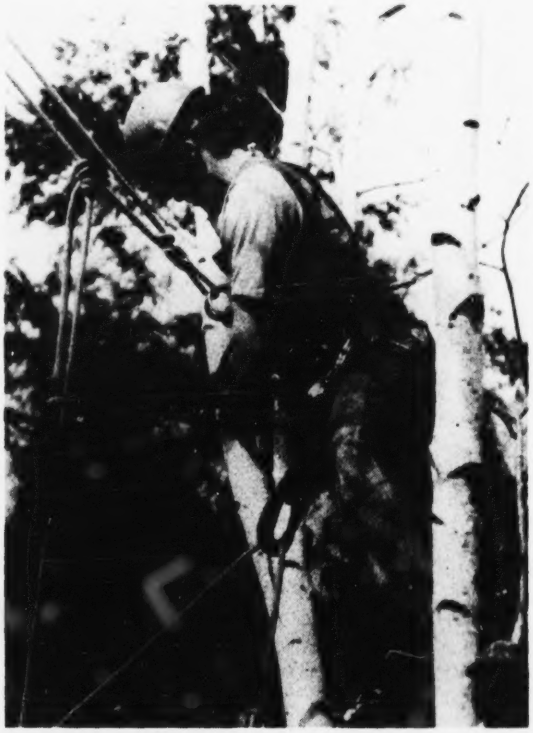


Figure 10.26. A tree worker installing a cable

Figure 10.25. Once measured, the cable can be attached and closed at the other end.

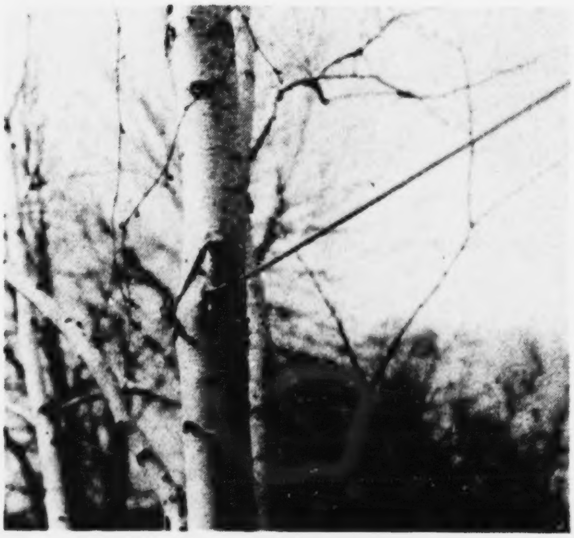


Figure 10.27. A simple or direct cable

Figure 10.28 illustrates some of the cable systems used with multiple cables.

Bracing may be used to support weak or split crotches or to strengthen decayed areas (Figure 10.29). Bracing is done with a threaded steel rod. A hole is first drilled with diameter 1/16 inch larger than the rod. This hole must pass straight through the entire portion to be braced. Do not attempt to drill from opposite ends and meet. The rod must pass clear through and be anchored in solid, sound wood. Rods, lags or eye bolts that dead-end in decaying wood will cause further decay and will not hold. Sometimes the screw rod is cut and used without nuts and washers, but this does not take full advantage of the holding potential of the rod.

After the rod has been threaded through the tree, the washers and nuts can be attached. Diamond-shaped washers have been used for some time, but research shows that sound closure may be more readily obtained using round or oval washers. The bark should be traced just enough for the washer to rest against the wood. Do not trace into the wood. Hex bolts can then be tightened onto the rod. If two or more rods are applied in bracing, it is best to place them parallel rather than one above the other.

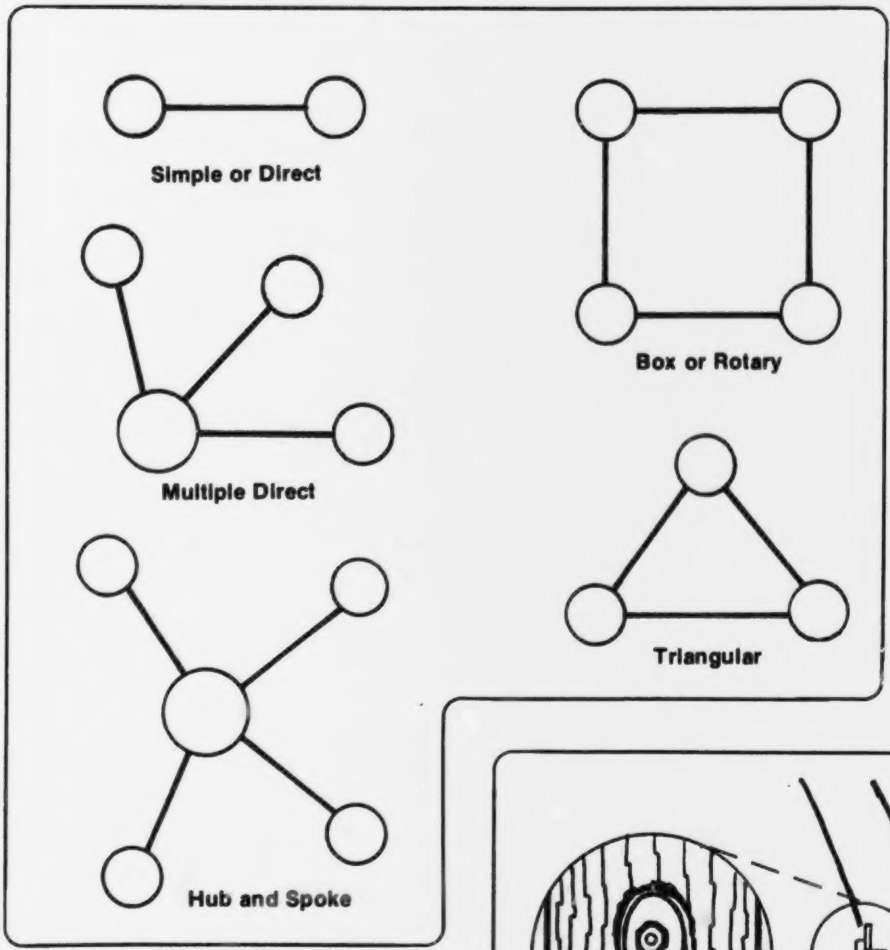


Figure 10.28. Cabling systems

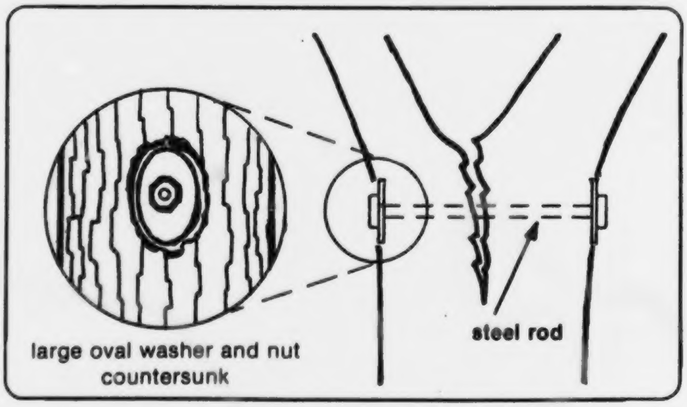


Figure 10.29. Bracing a split crotch

Lightning Protection Systems

A bolt of lightning can destroy a tree in less than a second. Trees can be blown apart, stripped of their bark, or caught on fire by lightning strike. People or animals standing under a tree can be killed when lightning strikes the tree. There are many circumstances that may warrant protecting a tree from lightning. Some trees are of historic value. Some trees on a golf course or in a park are popular places for refuge during a storm. Still others have high aesthetic or sentimental value. All these "special" trees should be equipped with lightning protection systems.

A lightning protection system consists of a series of conductors (copper cables) which extend from above the top of the tree, down the main branches, and are grounded (Figure 10.30). The air terminals or uppermost points of the cable are made by untwisting the strands of cable. There should be several air terminals above the high points of the main branches. The cable may be looped to allow for extension of the system as the tree grows. The cables are attached to the tree using special copper attachments which hold the conductor off the tree (Figure 10.31). The different forks of cable are spliced together using cable splice attachments. The primary conducting cable which extends down the main trunk should be composed of 32 strands of 17 gauge copper wire. For trees greater than 3 feet in diameter two standard down conductors should be placed on opposite sides of the tree.

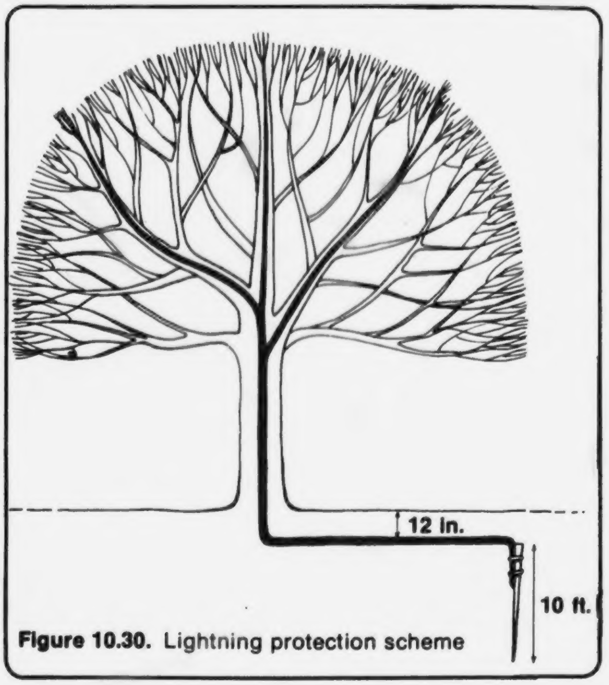


Figure 10.30. Lightning protection scheme

The conductor must be properly grounded. The cables extend out from the tree beyond the drip line and are buried 18 inches below the surface. The cables are attached to grounding rods which are buried to a depth of 10 feet. In dry, sandy or rocky soils, it is recommended that the cables be forked to several ground rods as shown in Figure 10.32. This forking method may also be used when other structures prevent grounding beyond the drip line. If two trees in close proximity are protected, their grounding cables may be connected. Grounding cables can also be attached to underground sprinkler systems.

Certainly the installation of a lightning protection system can be quite expensive. For this reason its uses have been limited. Studies have shown that certain trees are more susceptible to lightning damage and may be candidates for protection. Isolated trees and the tallest tree in an area are highly susceptible to lightning strike. Deep-rooted trees may be more susceptible to injury than shallow-rooted trees with extensive fibrous root systems. Thick, coarse-barked trees are damaged more frequently than thin, smooth-barked trees. Finally, decaying trees make excellent conductors and may be severely damaged.

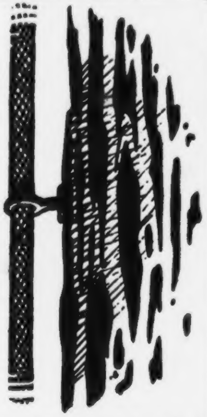


Figure 10.31. The cable should be attached to the tree at 4-foot intervals.

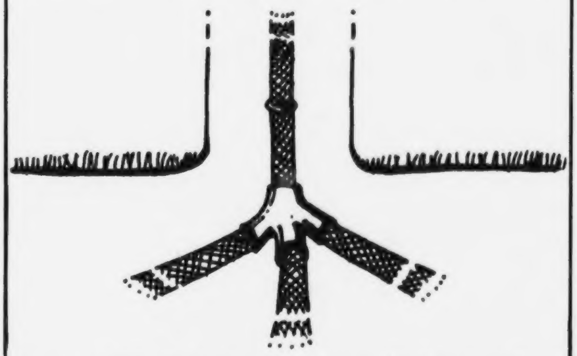


Figure 10.32. Forked cables for multiple grounding

Protecting Trees from Construction Damage

One of the major causes of tree decline and death that an arborist deals with is construction damage (Figure 10.33). Frequently people purchase houses on wooded lots for the aesthetic value and energy savings that trees provide. Trees can add thousands of dollars to the price of a lot. Unfortunately, many or all of the trees may be lost in subsequent years if proper steps were not previously taken to insure their survival. Symptoms of decline are often not obvious to the homeowner for three to five years after purchase of a property.

Before any construction is started, the decision must be made concerning which trees are to be saved and which removed. This decision should take into account the value, health and life span of each tree. From the builder's point of view construction needs must also be considered (Figure 10.34). Once the decision is made to save a tree, a realistic effort must be put forth to save it.

A fence should be erected around the tree or group of trees to be kept. The fence should be at least at the drip line, and ideally, beyond the drip line. This will help protect the tree from equipment that may break limbs, damage the trunk, and compact the soil. The heavy and repeated pressure of workers and equipment over the root zone of a tree compacts the soil, eliminating the pore spaces and oxygen supply to the roots. If it is not possible to keep traffic off the area, application of a temporary mulch of 6 to 10 inches will help to distribute the force and minimize compaction.

Excavation is another construction problem for trees. Excavations are made for utility lines and water pipes. If practical, the services should be routed around trees. It is better to tunnel directly under a tree than to cut across the root system. If roots are severed, a clean cut should be made and the soil backfilled immediately to minimize drying of the roots. It may help to prune some of the top portion of the tree to compensate for the root loss.

By far the biggest cause of construction damage to trees is changes in grade. Even a 4-inch fill can kill forest climax species such as beech, white oak, sugar maple and tuliptree. Fill dirt should be kept off the root zone if possible. When the grade must be changed, steps should be taken to protect the trees. In any case, the drainage pattern should not be changed.

If the grade is to be lowered, the trees may be protected by terracing to maintain some of the roots in their original root zone. This is not applicable in all instances, though. An alternate method is to construct a retaining wall. The backfill should be an organic material that will encourage new root growth.

For increases in grade the method of protection depends on the amount of fill to be added. For a minor fill of 1 to 3 inches, the treatment is rather simple. The root zone can be drilled as with fertilization and a coarse aggregate incorporated

Figure 10.33. Trees damaged by construction equipment

Figure 10.34. Trees may suffer if the construction worker gets distracted from the job.

into the holes. This will help provide oxygen to the roots.

For moderate fills up to 12 inches, building a dry well is the best procedure. A stone well is built around the trunk of the tree (Figure10.35). Ideally, the diameter of the well should be ten times the diameter of the tree. Certainly the well must be beyond the buttress roots. In addition, vertical tiles 3 inches in diameter should be placed beyond the well at a spacing of 2 feet on center. The tiles should extend to the drip line of the tree. The vertical drain tiles may be filled with sized gravel.

Major increases in grade require major steps to protect the tree. Since the expense involved is quite high, most builders are reluctant to take these steps unless the tree is valuable. If called in to consult, however, the arborist should insist on an adequate tree protection system.

Figure 10.36 illustrates the system for protecting a tree with a major grade change. As with moderate fills, a dry well should be built around the tree. Additional aeration and drainage tile are required, though. Four-inch-in-diameter tiles are laid on the original grade radiating out from the dry well like spokes of a wheel at 2-foot spacings. One tile should extend out of the fill and serve as a drain. Vertical tiles connect to the horizontal tiles and are covered with "bell caps" at the new grade.

The tiles are covered with sized gravel about 6 to 12 inches in depth. Over the gravel a soil filter separates the new top soil from the gravel. The separator may be a fiberglass matting or several inches of straw.

Protecting trees from construction damage can be time-consuming and costly. Large, stately trees can be worth the trouble involved. An arborist, when called upon to decide which trees should be saved, should also recommend what steps should be taken to protect the trees during construction.

The tree care professional performs a variety of operations to maintain the health and appearance of trees. Frequently tree workers must remove a tree that is in poor condition or simply unwanted. Yet taking the appropriate steps to save a tree provides true rewards.

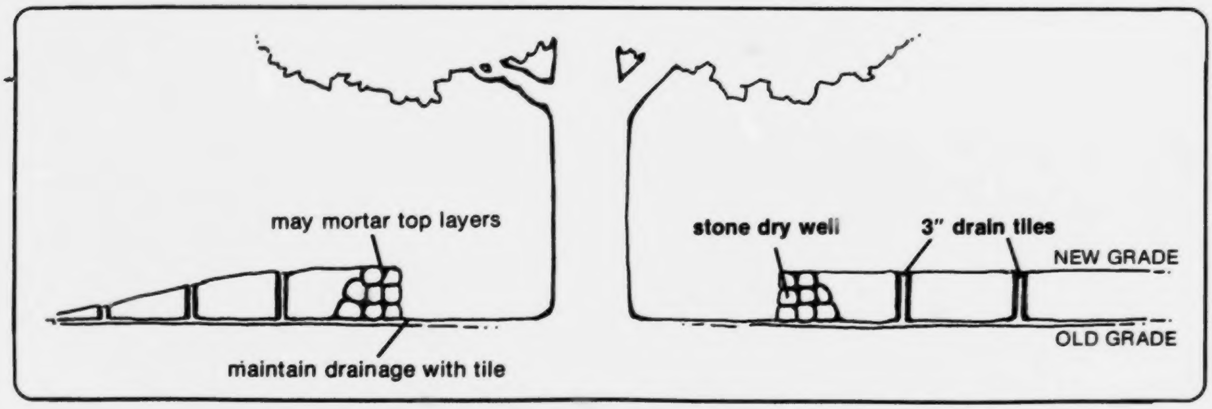


Figure 10.35. Tree protection system for moderate increases in grade

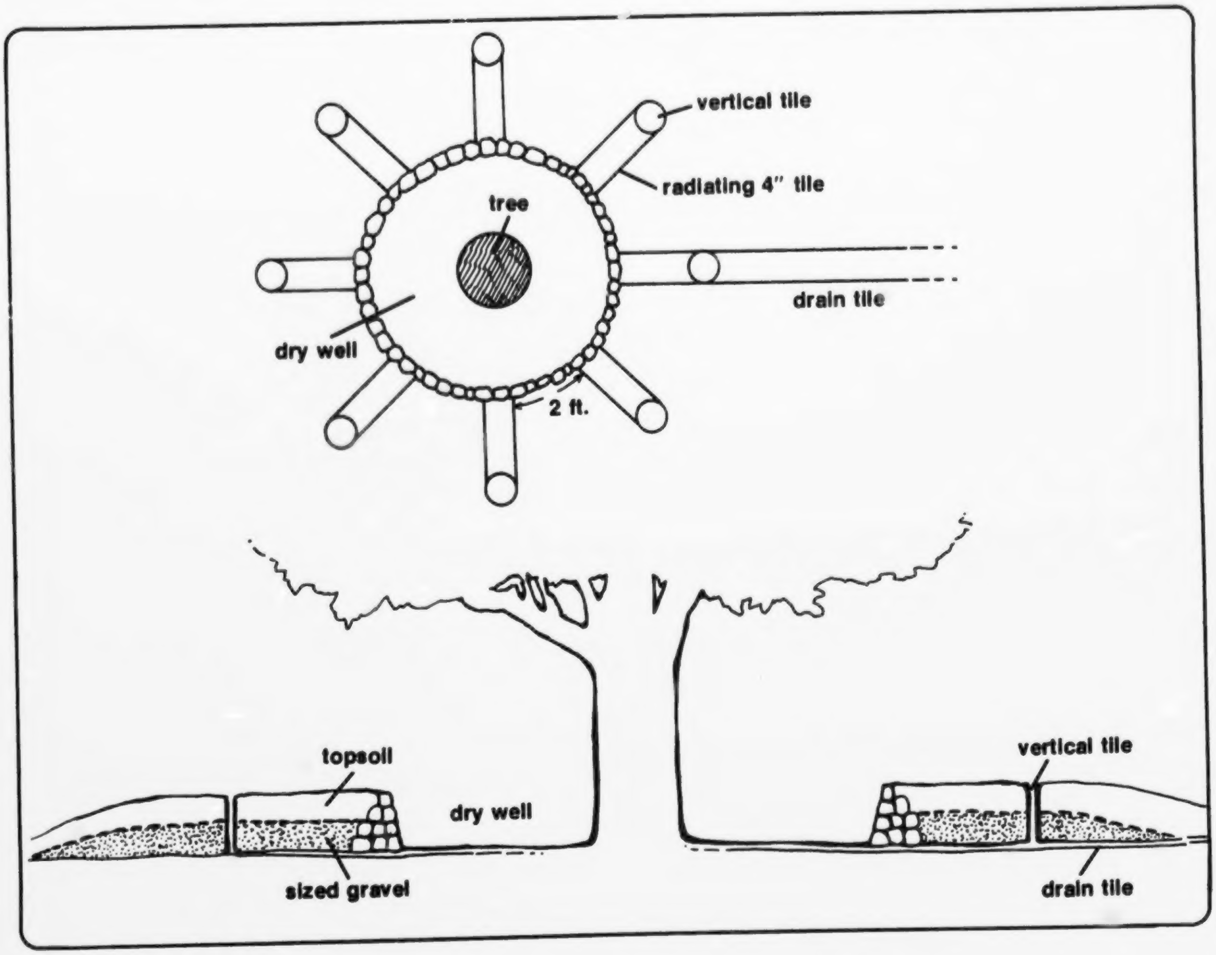

vertical tile
radiating 4" tile
tree
drain tile
dry well
2 ft.
topsoil
dry well
sized gravel
vertical tile
drain tile

Figure 10.36. Tree protection system for major grade change protection

APPENDIX I

FIRST AID PROCEDURES

Urgent Care Directions

1. Rescue the victim from any life-threatening situation.
2. If the victim is not breathing, begin artificial respiration.
3. Control severe bleeding.
4. Do not move the victim unless necessary.
5. If the victim has been poisoned, call a doctor or Poison Control Center immediately.
6. Support fractures.
7. Treat for shock.
8. Call or send for medical help.

Artificial Respiration

1. Tilt the victim's head back with one hand on the forehead. Use your other hand to support the victim's neck (Figure A-1).

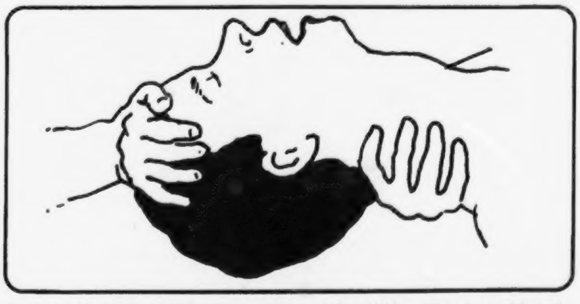


Figure A-1. Support the neck while tilting the head back.

2. Listen and feel for breathing by placing your ear and cheek close to the victim's mouth.
3. Check to see that the air passage is clear; remove obstructions if necessary.
4. Lightly pinch shut the victim's nose.
5. Take a deep breath. Create a tight seal around the victim's mouth with your mouth. Blow air into the victim's mouth (Figure A-2). Give four quick, full breaths.
6. Check again for breathing.
7. If victim is unable to breathe without assistance, provide a full breath of air every 5 seconds.

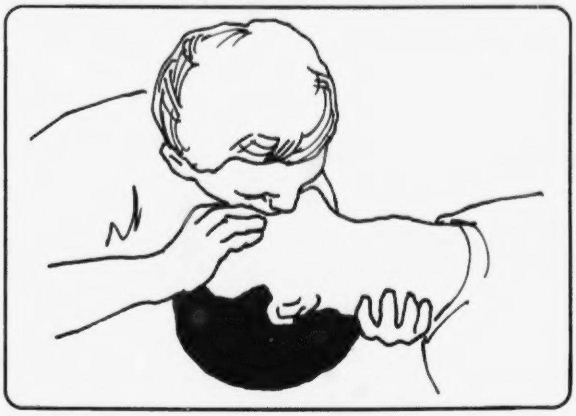


Figure A-2. Blow gently into the victim's mouth.

Cardiopulmonary Resuscitation (CPR)

NOTE: **CPR requires special training and should be carried out only by qualified persons.** (This section is intended to serve as a reminder for trained persons.)

1. Attempt to arouse the victim.
2. Open the airway by tilting the head back.
3. Look, listen and feel for breathing. If there is no breathing . . .
4. Apply artificial respiration.
5. Feel for the carotid pulse in the groove of the neck beside the Adam's apple (Figure A-3). If the pulse is absent . . .
6. Place victim on back on a flat, firm, horizontal surface.

(continued)

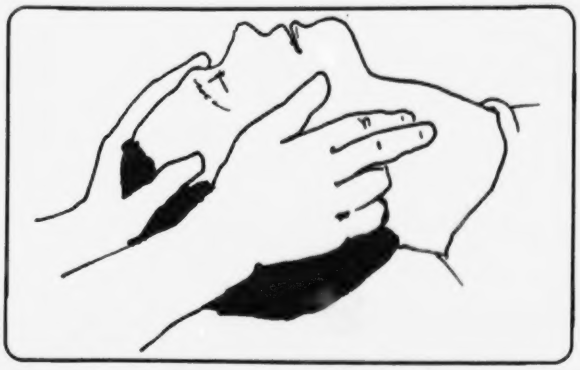


Figure A-3. Feel the neck for a pulse.

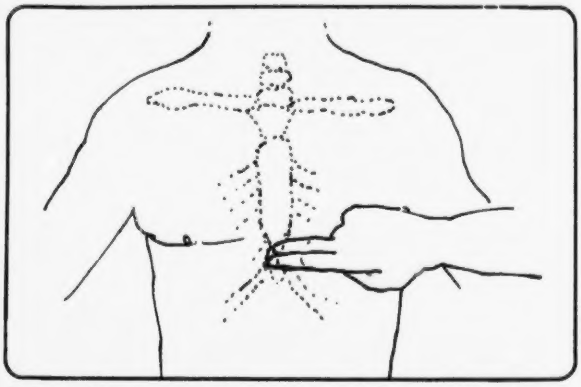


Figure A-4. Locate the correct position on the chest.

7. Locate the xiphoid tip (the "V" in the center of the chest where the ribs meet). Measure two finger-widths up on the breastbone (Figure A-4).

8. Place one hand over the other. Exert pressure vertically and depress the chest 1½ to 2 inches, keeping your arms and elbows straight (Figure A-5).

9. After each compression release pressure completely but do not remove hands from that position.

   Two rescuers: 5:1 ratio, 60 compressions per minute, one lung inflation after every five compressions without breaking the count.

   One rescuer: 15:2 ratio, 80 compressions per minute, 2 quick lung inflations following each 15 compressions. Be sure to reposition hands before resuming compressions.

10. Always continue CPR procedures until the victim is revived or until professional help arrives.

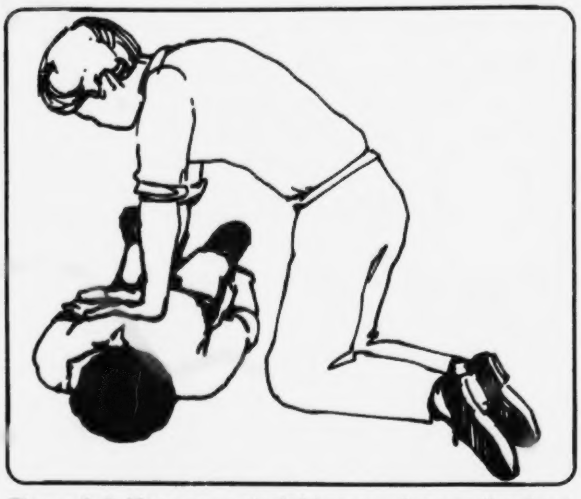


Figure A-5. Keep arms straight as you depress the chest.

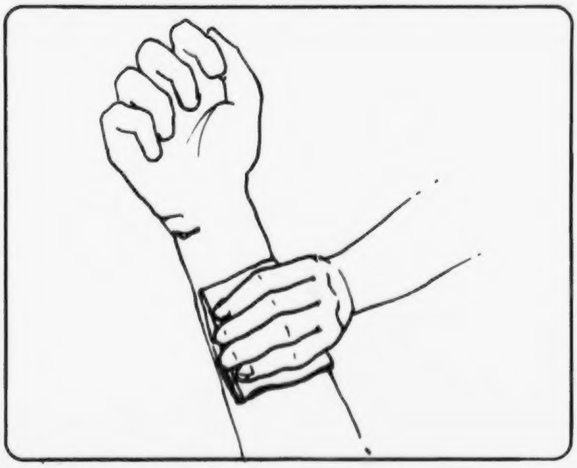


Figure A-6. Apply firm pressure to a bleeding wound.

Severe Bleeding

1. Apply direct pressure firmly on the wound. A thick pad of cloth (sterile if possible) between the hand and wound will help control bleeding (Figure A-6).

2. Elevate the wound if practical.

3. If bleeding continues, apply direct pressure on a pressure point to help stop bleeding from a wound in an arm or leg (Figure A-7). Press the main supply artery against the underlying bone (Figure A-8).

4. Do not apply a tourniquet unless medical help is available.

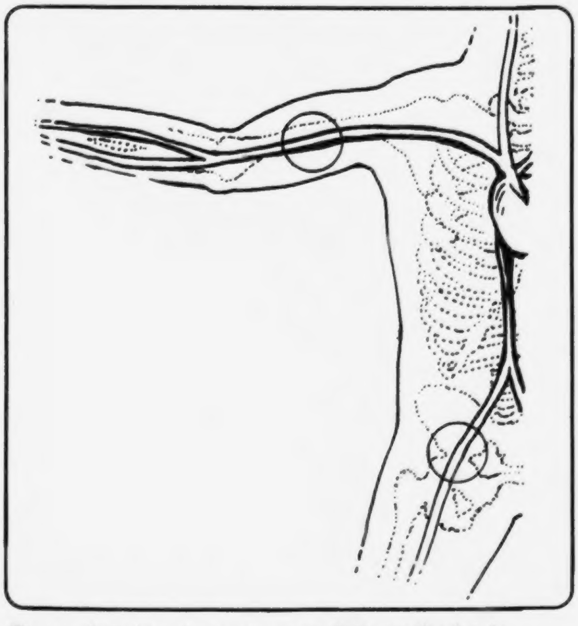


Figure A-7. Locate pressure points on the body.

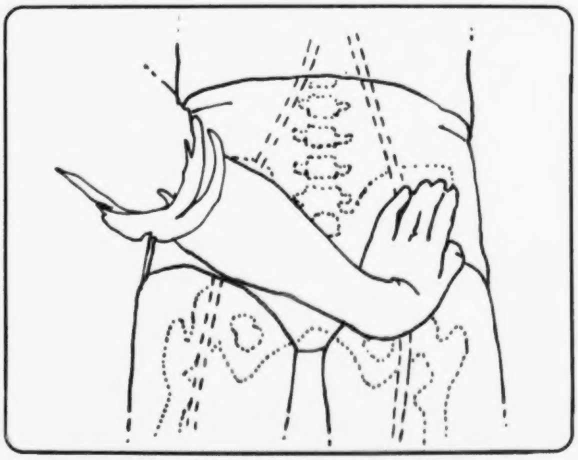


Figure A-8. Press the artery against the bone.

Head Injuries

1. Do not attempt to cleanse scalp wounds, as this may cause severe bleeding or severe contamination.
2. Control bleeding by raising the victim's head.
3. Place a sterile dressing on the wound, but do not apply excessive pressure.
4. Do not give the victim fluids by mouth.
5. Record the extent and duration of unconsciousness.

Burns

1. Minor burns: ***first degree*** (redness, swelling)

   Apply cold water or ice.

2. More serious burns: ***second degree*** (redness, mottled appearance, blisters, swelling)

   Wrap in clean, dry cloth.
   Do not pop blisters.
   Do not apply ointment.
   Seek medical help.

3. Severe burns: ***third degree*** (tissue destruction, glossy white appearance)

   Cover burn with clean, dry cloth.
   Seek medical help immediately.

Treatment for Shock

SYMPTOMS:

pale, cold, moist and clammy skin
the whole body weak
pulse weak and rapid
irregular breathing, often shallow
nausea, vomiting
pupils dilated

1. Keep the victim lying down. Elevate the feet if this will not aggravate other injuries (Figure A-9).
2. Keep the victim warm. Cover with blanket if necessary.
3. Get medical help.

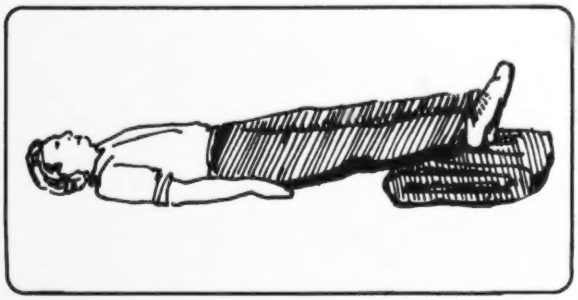


Figure A-9. The feet of the victim could be elevated when the victim is in shock.

Heat Stroke, Heat Cramps and Heat Exhaustion

Heat Stroke

SYMPTOMS:

high body temperature
skin hot, red and dry
pulse strong and rapid
sometimes victim unconscious

1. Take immediate measures to cool the victim's body.
   - Remove the victim's clothing and cool the body with cool water or rubbing alcohol.
   - Use fans or cold packs if available.
2. Monitor body temperature and reduce if necessary.

Heat Cramps

1. Firmly massage the cramped muscle.
2. Give the victim sips of salt water every 15 minutes for an hour (1 teaspoon of salt per glass).

Heat Exhaustion

SYMPTOMS:

approximately normal body temperature
pale, clammy skin
heavy perspiration
weakness, fatigue
headache or cramps
dizziness, nausea or vomiting

1. Give the victim sips of salt water every 15 minutes for an hour (1 teaspoon of salt per glass).
2. Keep the victim lying down and raise the feet.
3. Keep the victim cool.
4. If vomiting occurs, discontinue giving fluids.
5. Take the victim to a hospital if symptoms continue.

Poisonous Insect Bites

Minor bites and stings:

Apply ice to reduce swelling.
Apply soothing lotions.

Tick bites:

Cover the tick with heavy oil to close its breathing pores. If tick does not disengage, leave the oil on for ½ hour, then carefully remove the tick with tweezers.

Severe reactions to bites or stings:

1. Give artificial respiration if required.
2. Apply a restricting band above the site if practical. You should be able to slip your finger under the band when in place.
3. Keep the affected part of the body below the victim's heart.
4. Apply ice and treat for shock.
5. Get medical help if the victim is allergic.
6. In the case of a bee sting, remove the stinger with tweezers. Be careful not to squeeze the attached venom sac, as this would inject more venom.

Contact with Poisonous Plants

POISON IVY - ***Rhus radicans, Rhus toxicodendron*** (Figure A-10)

small shrub or vine
leaves composed of three leaflets, orange-red in fall
fruit - white berries
distribution - most of U.S., although different varieties inhabit different regions

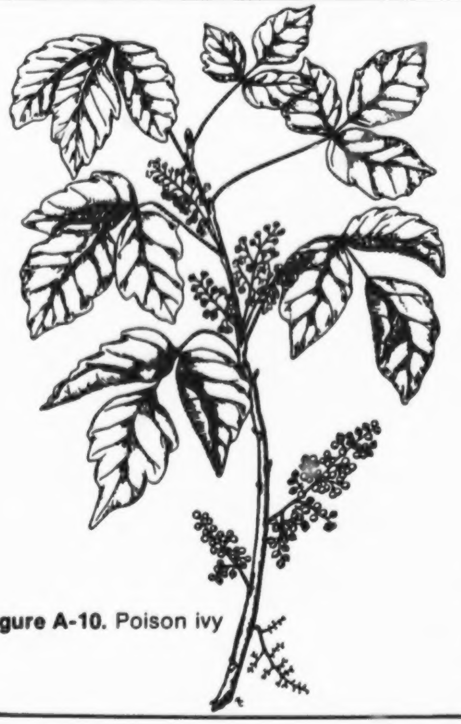


Figure A-10. Poison ivy

WESTERN POISON OAK - ***Rhus diversiloba***

usually in shrub form, sometimes vine
leaves composed of three leaflets
fruit - white berries
distribution - western North America

POISON SUMAC - ***Rhus vernix***

woody shrub or small tree, 5 to 25 feet tall
compound leaves, 7-11 leaflets
fruit - glossy, pale yellow, pendant when ripe
distribution - predominantly east of the Mississippi River, swampy areas

1. Wash affected area with strong soap and water.
2. Wash with rubbing alcohol.
3. Seek medical help if a severe reaction occurs in the next day or two.

APPENDIX II

SELECTED COMMON PLANTS OF NORTH AMERICA

LISTED ALPHABETICALLY BY ***SCIENTIFIC NAME***

Scientific Name	Common Name	Family
Abelia x grandiflora	Glossy Abelia	Caprifoliaceae
Abies balsamea	Balsam Fir	Pinaceae
Abies concolor	White Fir	Pinaceae
Abies fraseri	Fraser Fir	Pinaceae
Abies procera	Noble Fir	Pinaceae
Acanthopanax sieboldianus	Fiveleaf Aralia	Araliaceae
Acer buergerianum	Trident Maple	Aceraceae
Acer campestre	Hedge Maple	Aceraceae
Acer ginnala	Amur Maple	Aceraceae
Acer griseum	Paperbark Maple	Aceraceae
Acer japonicum	Fullmoon Maple	Aceraceae
Acer negundo	Boxelder	Aceraceae
Acer palmatum	Japanese Maple	Aceraceae
Acer pensylvanicum	Striped Maple, Moosewood	Aceraceae
Acer platanoides	Norway Maple	Aceraceae
Acer pseudoplatanus	Planetree Maple, Sycamore Maple	Aceraceae
Acer rubrum	Red Maple	Aceraceae
Acer saccharinum	Silver Maple	Aceraceae
Acer saccharum	Sugar Maple, Rock Maple, Hard Maple	Aceraceae
Acer tataricum	Tatarian Maple	Aceraceae
Aesculus carnea	Red Horsechestnut	Hippocastanaceae
Aesculus glabra	Ohio Buckeye, Fetid Buckeye	Hippocastanaceae
Aesculus hippocastanum	Common Horsechestnut	Hippocastanaceae
Aesculus octandra	Yellow Buckeye	Hippocastanaceae
Aesculus parviflora	Bottlebrush Buckeye	Hippocastanaceae
Aesculus pavia	Red Buckeye	Hippocastanaceae
Ailanthus altissima	Tree-of-Heaven	Simaroubaceae
Akebia quinata	Fiveleaf Akebia	Lardizabalaceae
Albizia julibrissin	Mimosa, Albizia, Silk-tree	Leguminosae
Alnus glutinosa	European Alder, Common Alder, Black Alder	Betulaceae
Amelanchier laevis	Allegheny Serviceberry	Rosaceae
Amelanchier stolonifera	Running Serviceberry	Rosaceae
Ampelopsis brevipedunculata	Porcelain Ampelopsis	Vitaceae
Aralia spinosa	Devil's-walkingstick, Hercules-club	Araliaceae
Arctostaphylos uva-ursi	Bearberry	Ericaceae
Aronia arbutifolia	Red Chokeberry	Rosaceae
Aronia melanocarpa	Black Chokeberry	Rosaceae
Asimina triloba	Common Pawpaw	Annonaceae
Berberis x chenaultii	Chenault Barberry	Berberidaceae
Berberis julianae	Wintergreen Barberry	Berberidaceae
Berberis koreana	Korean Barberry	Berberidaceae
Berberis x mentorensis	Mentor Barberry	Berberidaceae
Berberis thunbergii	Japanese Barberry	Berberidaceae
Betula lenta	Sweet Birch	Betulaceae
Betula maximowicziana	Monarch Birch	Betulaceae
Betula nigra	River Birch	Betulaceae
Betula papyrifera	Paper Birch, White Birch, Canoe Birch	Betulaceae
Betula pendula	European White Birch	Betulaceae
Betula platyphylla	Asian White Birch	Betulaceae
Betula populifolia	Gray Birch, Poplar Birch	Betulaceae
Buxus microphylla	Littleleaf Box, Boxwood	Buxaceae
Buxus sempervirens	Common Box, Boxwood	Buxaceae
Calycanthus floridus	Common Sweetshrub, Carolina Allspice, Strawberry-shrub	Calycanthaceae
Campsis radicans	Common Trumpetcreeper	Bignoniaceae
Caragana arborescens	Siberia Peashrub	Leguminosae
Carpinus betulus	European Hornbeam	Betulaceae
Carpinus caroliniana	American Hornbeam, Blue Beech, Ironwood	Betulaceae
Carya cordiformis	Bitternut Hickory	Juglandaceae
Carya illinoinensis	Pecan	Juglandaceae
Carya ovata	Shagbark Hickory	Juglandaceae

Scientific Name	Common Name	Family
Castanea dentata	American Chestnut	Fagaceae
Castanea mollissima	Chinese Chestnut	Fagaceae
Catalpa bignonioides	Southern Catalpa, Common Catalpa, Indian Bear	Bignoniaceae
Catalpa speciosa	Northern Catalpa, Western Catalpa, Hardy Catalpa	Bignoniaceae
Cedrus atlantica	Atlas Cedar	Pinaceae
Cedrus deodara	Deodar Cedar	Pinaceae
Cedrus libani	Cedar of Lebanon	Pinaceae
Celastrus scandens	American Bittersweet	Celastraceae
Celtis laevigata	Sugar Hackberry	Ulmaceae
Celtis occidentalis	Common Hackberry	Ulmaceae
Cercidiphyllum japonicum	Katsuratree	Cercidiphyllaceae
Cercis canadensis	Eastern Redbud	Leguminosae
Chaenomeles japonica	Japanese Floweringquince	Rosaceae
Chaenomeles speciosa	Common Floweringquince	Rosaceae
Chamaecyparis lawsoniana	Lawson Falsecypress	Cupressaceae
Chamaecyparis nootkatensis	Nootka Falsecypress	Cupressaceae
Chamaecyparis obtusa	Hinoki Falsecypress	Cupressaceae
Chamaecyparis pisifera	Japanese Falsecypress, Sawara	Cupressaceae
Chionanthus virginicus	White Fringetree	Oleaceae
Cladrastis lutea	American Yellowwood, Virgilia	Leguminosae
Clematis x jackmanii	Jackman Clematis	Ranunculaceae
Clethra alnifolia	Summersweet Clethra	Clethraceae
Cornus alba	Tatarian Dogwood	Cornaceae
Cornus alternifolia	Pagoda Dogwood	Cornaceae
Cornus amomum	Silky Dogwood	Cornaceae
Cornus florida	Flowering Dogwood	Cornaceae
Cornus kousa	Kousa Dogwood	Cornaceae
Cornus mas	Corneliancherry Dogwood	Cornaceae
Cornus racemosa	Gray Dogwood	Cornaceae
Cornus sanguinea	Bloodtwig Dogwood	Cornaceae
Cornus stolonifera	Redosier Dogwood	Cornaceae
Corylopsis glabrescens	Fragrant Winterhazel	Hamamelidaceae
Corylus americana	American Filbert	Betulaceae
Corylus avellana	European Filbert	Betulaceae
Corylus colurna	Turkish Filbert, Hazel	Betulaceae
Corylus maxima purpurea	Purple Giant Filbert	Betulaceae
Cotinus coggygria	Common Smoketree, Smokebush	Anacardiaceae
Cotoneaster apiculata	Cranberry Cotoneaster	Rosaceae
Cotoneaster dammeri	Bearberry Cotoneaster	Rosaceae
Cotoneaster divaricata	Spreading Cotoneaster	Rosaceae
Cotoneaster horizontalis	Rock Cotoneaster, Rockspray	Rosaceae
Cotoneaster lucida	Hedge Cotoneaster	Rosaceae
Cotoneaster multiflora	Many-flowered Cotoneaster	Rosaceae
Cotoneaster salicifolia	Willowleaf Cotoneaster	Rosaceae
Crataegus crusgalli	Cockspur Hawthorn	Rosaceae
Crataegus x lavallei	Lavalle Hawthorn	Rosaceae
Crataegus mollis	Downy Hawthorn	Rosaceae
Crataegus nitida	Glossy Hawthorn	Rosaceae
Crataegus oxyacantha	English Hawthorn	Rosaceae
Crataegus phaenopyrum	Washington Hawthorn	Rosaceae
Cryptomeria japonica	Japanese Cryptomeria	Taxodiaceae
Cunninghamia lanceolata	Common Chinafir	Taxodiaceae
Deutzia gracilis	Slender Deutzia	Saxifragaceae
Deutzia scabra	Fuzzy Deutzia	Saxifragaceae
Diospyros virginiana	Common Persimmon	Ebenaceae
Elaeagnus angustifolia	Russian Olive	Elaeagnaceae
Elaeagnus umbellata	Autumn Elaeagnus	Elaeagnaceae
Enkianthus campanulatus	Redvein Enkianthus	Ericaceae
Eucommia ulmoides	Hardy Rubber Tree	Eucommiaceae
Euonymus alatus	Winged Euonymus	Celastraceae
Euonymus bungeanus	Winterberry Euonymus	Celastraceae
Euonymus fortunei	Wintercreeper Euonymus	Celastraceae
Euonymus kiautschovicus	Spreading Euonymus	Celastraceae
Fagus grandifolia	American Beech	Fagaceae

Scientific Name	Common Name	Family
Fagus sylvatica	European Beech	Fagaceae
Forsythia x intermedia	Border Forsythia	Oleaceae
Forsythia suspensa	Weeping Forsythia	Oleaceae
Forsythia viridissima	Greenstem Forsythia	Oleaceae
Fothergilla gardenii	Dwarf Fothergilla	Hamamelidaceae
Fothergilla major	Large Fothergilla	Hamamelidaceae
Franklinia alatamaha	Franklinia, Franklin Tree	Theaceae
Fraxinus americana	White Ash	Oleaceae
Fraxinus excelsior	European Ash	Oleaceae
Fraxinus pennsylvanica	Green Ash, Red Ash	Oleaceae
Fraxinus quadrangulata	Blue Ash	Oleaceae
Fraxinus tomentosa	Pumpkin Ash	Oleaceae
Gingko biloba	Ginkgo, Maidenhair Tree	Ginkgoaceae
Gleditsia triacanthos var. inermis	Thornless Honeylocust	Leguminosae
Gymnocladus dioicus	Kentucky Coffeetree	Leguminosae
Halesia carolina	Carolina Silverbell	Styracaceae
Hamamelis mollis	Chinese Witchhazel	Hamamelidaceae
Hamamelis vernalis	Vernal Witchhazel	Hamamelidaceae
Hamamelis virginiana	Common Witchhazel	Hamamelidaceae
Hedera helix	English Ivy	Araliaceae
Hibiscus syriacus	Rose-of-Sharon, Shrub Althea	Malvaceae
Hydrangea anomala subsp. petiolaris	Climbing Hydrangea	Saxifragaceae
Hydrangea arborescens	Smooth Hydrangea	Saxifragaceae
Hydrangea paniculata	Panicle Hydrangea	Saxifragaceae
Hydrangea quercifolia	Oakleaf Hydrangea	Saxifragaceae
Hypericum prolificum	Shrubby St. Johnswort	Guttiferae
Iberis sempervirens	Candytuft	Cruciferae
Ilex cornuta	Chinese Holly	Aquifoliaceae
Ilex crenata	Japanese Holly	Aquifoliaceae
Ilex decidua	Possumhaw	Aquifoliaceae
Ilex x fosteri	Foster's Holly	Aquifoliaceae
Ilex glabra	Inkberry	Aquifoliaceae
Ilex x meserveae	Blue Holly, Meserve Holly	Aquifoliaceae
Ilex opaca	American Holly	Aquifoliaceae
Ilex pedunculosa	Longstalk Holly	Aquifoliaceae
Ilex verticillata	Common Winterberry, Black Alder, Coralberry, Michigan Holly	Aquifoliaceae
Juglans cinerea	Butternut	Juglandaceae
Juglans nigra	Black Walnut	Juglandaceae
Juniperus chinensis	Chinese Juniper	Cupressaceae
Juniperus communis	Common Juniper	Cupressaceae
Juniperus conferta	Shore Juniper	Cupressaceae
Juniperus horizontalis	Creeping Juniper	Cupressaceae
Juniperus procumbens	Japanese Garden Juniper	Cupressaceae
Juniperus sabina	Savin Juniper	Cupressaceae
Juniperus scopulorum	Rocky Mountain Juniper	Cupressaceae
Juniperus squamata	Singleseed Juniper	Cupressaceae
Juniperus virginiana	Eastern Redcedar	Cupressaceae
Kalmia latifolia	Mountain Laurel Kalmia	Ericaceae
Kalopanax pictus	Castor-aralia	Araliaceae
Kerria japonica	Japanese Kerria	Rosaceae
Koelreuteria paniculata	Panicled Goldenraintree, Varnish Tree	Sapindaceae
Kolkwitzia amabilis	Beautybush	Caprifoliaceae
Laburnum x watereri	Goldenchain Tree, Waterer Laburnum	Leguminosae
Larix decidua	European Larch	Pinaceae
Larix kaempferi	Japanese Larch	Pinaceae
Leucothoe fontanesiana	Drooping Leucothoe, Fetterbush	Ericaceae
Ligustrum amurense	Amur Privet	Oleaceae
Ligustrum obtusifolium	Border Privet	Oleaceae
Ligustrum x vicaryi	Golden Privet	Oleaceae
Ligustrum vulgare	European Privet	Oleaceae
Lindera benzoin	Spicebush	Lauraceae
Liquidambar styraciflua	Sweetgum	Hamamelidaceae
Liriodendron tulipifera	Tuliptree, Tulip Poplar, Tulip Magnolia, Yellow Poplar	Magnoliaceae

Scientific Name	**Common Name**	**Family**
Liriope spicata	Lilyturf	Liliaceae
Lonicera fragrantissima	Winter Honeysuckle	Caprifoliaceae
Lonicera japonica	Japanese Honeysuckle	Caprifoliaceae
Lonicera maackii	Amur Honeysuckle	Caprifoliaceae
Lonicera sempervirens	Trumpet Honeysuckle	Caprifoliaceae
Lonicera tatarica	Tatarian Honeysuckle	Caprifoliaceae
Maclura pomifera	Osage-orange, Hedge-apple	Moraceae
Magnolia acuminata	Cucumbertree Magnolia	Magnoliaceae
Magnolia grandiflora	Southern Magnolia	Magnoliaceae
Magnolia kobus	Kobus Magnolia	Magnoliaceae
Magnolia liliflora	Lily Magnolia	Magnoliaceae
Magnolia macrophylla	Bigleaf Magnolia	Magnoliaceae
Magnolia x soulangiana	Saucer Magnolia	Magnoliaceae
Magnolia stellata	Star Magnolia	Magnoliaceae
Magnolia tripetala	Umbrella Magnolia	Magnoliaceae
Magnolia virginiana	Sweetbay Magnolia, Swamp Magnolia, Laurel	Magnoliaceae
Mahonia aquifolium	Oregon Grapeholly	Berberidaceae
Malus spp.	Flowering Crabapple	Rosaceae
Metasequoia glyptostroboides	Dawn Redwood	Taxodiaceae
Morus alba	White Mulberry, Common Mulberry	Moraceae
Morus rubra	Red Mulberry	Moraceae
Myrica pensylvanica	Northern Bayberry	Myricaceae
Neviusia alabamensis	Snow-wreath	Rosaceae
Nyssa sylvatica	Black Gum, Sour Gum, Black Tupelo, Pepperidge	Nyssaceae
Ostrya virginiana	American Hophornbeam, Ironwood	Betulaceae
Oxydendrum arboreum	Sourwood, Sorrel Tree, Lily-of-the-valley Tree	Ericaceae
Pachysandra terminalis	Japanese Pachysandra, Spurge	Buxaceae
Parthenocissus quinquefolia	Virginia Creeper, Woodbine	Vitaceae
Parthenocissus tricuspidata	Japanese Creeper	Vitaceae
Paxistima canbyi	Canby Paxistima	Celastraceae
Phellodendron amurense	Amur Corktree	Rutaceae
Philadelphus coronarius	Sweet Mockorange	Saxifragaceae
Photinia villosa	Oriental Photinia	Rosaceae
Physocarpus opulifolius	Common Ninebark, Eastern Nineback	Rosaceae
Picea abies	Norway Spruce	Pinaceae
Picea engelmannii	Engelmann Spruce	Pinaceae
Picea glauca	White Spruce	Pinaceae
Picea omorika	Serbian Spruce	Pinaceae
Picea orientalis	Oriental Spruce	Pinaceae
Picea pungens	Colorado Spruce	Pinaceae
Picea pungens glauca	Blue Spruce	Pinaceae
Pieris floribunda	Mountain Pieris	Ericaceae
Pieris japonica	Japanese Pieris, Andromeda	Ericaceae
Pinus aristata	Bristlecone Pine	Pinaceae
Pinus banksiana	Jack Pine	Pinaceae
Pinus bungeana	Lacebark Pine	Pinaceae
Pinus cembra	Swiss Stone Pine	Pinaceae
Pinus densiflora	Japanese Red Pine	Pinaceae
Pinus edulus	Colorado Pinyon Pine	Pinaceae
Pinus flexilis	Limber Pine	Pinaceae
Pinus mugo	Swiss Mountain Pine	Pinaceae
Pinus mugo mugo	Dwarf Swiss Mountain Pine	Pinaceae
Pinus nigra	Austrian Pine	Pinaceae
Pinus parviflora	Japanese White Pine	Pinaceae
Pinus ponderosa	Ponderosa Pine	Pinaceae
Pinus resinosa	Red Pine	Pinaceae
Pinus rigida	Pitch Pine	Pinaceae
Pinus strobus	Eastern White Pine	Pinaceae
Pinus sylvestris	Scotch Pine	Pinaceae
Pinus thunbergiana	Japanese Black Pine	Pinaceae
Pinus virginiana	Virginia Pine, Scrub Pine, Jersey Pine, Spruce Pine, Poverty Pine	Pinaceae
Pinus wallichiana	Himalayan Pine	Pinaceae

Scientific Name	Common Name	Family
Platanus acerifolia	London Planetree	Platanaceae
Platanus occidentalis	Sycamore, American Planetree	Platanaceae
Populus alba	White Poplar, Silver-leaved Poplar	Salicaceae
Populus deltoides	Eastern Cottonwood	Salicaceae
Populus tremuloides	Quaking Aspen	Salicaceae
Potentilla fruticosa	Bush Cinquefoil	Rosaceae
Prunus cerasifera	Cherry Plum	Rosaceae
Prunus glandulosa	Dwarf Flowering Almond	Rosaceae
Prunus persica	Common Peach	Rosaceae
Prunus serotina	Black Cherry	Rosaceae
Prunus serrulata	Oriental Cherry	Rosaceae
Prunus subhirtella	Higan Cherry	Rosaceae
Prunus tomentosa	Manchu Cherry, Nanking Cherry	Rosaceae
Prunus triloba	Flowering Plum	Rosaceae
Prunus virginiana	Common Chokecherry	Rosaceae
Pseudolarix kaempferi	Golden-larch	Pinaceae
Pseudotsuga menziesii	Douglasfir	Pinaceae
Pyracantha coccinea	Scarlet Firethorn	Rosaceae
Pyrus calleryana	Callery Pear	Rosaceae
Pyrus communis	Common Pear	Rosaceae
Pyrus salicifolia	Willowleaf Pear	Rosaceae
Quercus acutissima	Sawtooth Oak	Fagaceae
Quercus alba	White Oak	Fagaceae
Quercus bicolor	Swamp White Oak	Fagaceae
Quercus coccinea	Scarlet Oak	Fagaceae
Quercus imbricaria	Shingle Oak, Laurel Oak	Fagaceae
Quercus macrocarpa	Bur Oak, Mossycup Oak	Fagaceae
Quercus muehlenbergii	Chinkapin Oak, Yellow Chestnut Oak	Fagaceae
Quercus palustris	Pin Oak, Swamp Oak	Fagaceae
Quercus phellos	Willow Oak	Fagaceae
Quercus prinus	Chestnut Oak	Fagaceae
Quercus robur	English Oak	Fagaceae
Quercus rubra	Red Oak	Fagaceae
Quercus shumardi	Shumard Oak	Fagaceae
Quercus variabilis	Oriental Oak	Fagaceae
Quercus velutina	Black Oak	Fagaceae
Rhamnus cathartica	Common Buckthorn	Rhamnaceae
Rhamnus frangula	Glossy Buckthorn	Rhamnaceae
Rhododendron spp.	Rhododendron, Azalea	Ericaceae
Rhodotypos scandens	Black Jetbead	Rosaceae
Rhus aromatica	Fragrant Sumac	Anacardiaceae
Rhus chinensis	Chinese Sumac	Anacardiaceae
Rhus copallina	Flameleaf Sumac	Anacardiaceae
Rhus glabra	Smooth Sumac	Anacardiaceae
Rhus typhina	Staghorn Sumac	Anacardiaceae
Ribes alpinum	Alpine Currant	Saxifragaceae
Ribes odoratum	Clove Currant	Saxifragaceae
Robinia pseudoacacia	Black Locust, Common Locust	Leguminosae
Salix alba	White Willow	Salicaceae
Salix babylonica	Babylon Weeping Willow	Salicaceae
Salix caprea	Goat Willow	Salicaceae
Salix discolor	Pussy Willow	Salicaceae
Salix matsudana 'Tortuosa'	Corkscrew Willow	Salicaceae
Sambucus canadensis	American Elder	Caprifoliaceae
Sassafras albidum	Common Sassafras	Lauraceae
Sciadopitys verticillata	Umbrella-pine	Pinaceae
Sophora japonica	Japanese Pagodatree, Scholar-tree	Leguminosae
Sorbus alnifolia	Korean Mountainash	Rosaceae
Sorbus americana	American Mountainash	Rosaceae
Sorbus aucuparia	European Mountainash	Rosaceae
Spiraea arguta	Garland Spirea	Rosaceae
Spiraea x bumalda	Bumald Spirea	Rosaceae
Spiraea prunifolia	Bridalwreath Spirea	Rosaceae
Spiraea thunbergii	Thunberg Spirea	Rosaceae
Spiraea x vanhouttei	Vanhoutte Spirea	Rosaceae
Staphylea trifolia	American Bladdernut	Staphyleaceae

Scientific Name	**Common Name**	**Family**
Stephanandra incisa	Cutleaf Stephanandra	Rosaceae
Stewartia ovata	Mountain Stewartia	Theaceae
Stewartia pseudo-camellia	Japanese Stewartia	Theaceae
Styrax japonicum	Japanese Snowbell	Styracaceae
Symphoricarpos albus	Common Snowberry	Caprifoliaceae
Symphoricarpos x chenaultii	Chenault Coralberry	Caprifoliaceae
Symphoricarpos orbiculatus	Indiancurrant Coralberry	Caprifoliaceae
Syringa x chinensis	Chinese Lilac	Oleaceae
Syringa meyeri	Meyer Lilac	Oleaceae
Syringa reticulata	Japanese Tree Lilac	Oleaceae
Syringa villosa	Late Lilac	Oleaceae
Syringa vulgaris	Common Lilac	Oleaceae
Taxodium ascendens	Pondcypress	Taxodiaceae
Taxodium distichum	Baldcypress	Taxodiaceae
Taxus baccata	English Yew	Taxaceae
Taxus canadensis	Canadian Yew	Taxaceae
Taxus cuspidata	Japanese Yew	Taxaceae
Taxus x media	Anglo-Japanese Yew	Taxaceae
Thuja occidentalis	Eastern Arborvitae	Cupressaceae
Thuja orientalis	Oriental Arborvitae	Cupressaceae
Tilia americana	American Linden	Tiliaceae
Tilia cordata	Littleleaf Linden	Tiliaceae
Tilia x euchlora	Crimean Linden	Tiliaceae
Tilia x europaea	European Linden	Tiliaceae
Tilia heterophylla	Beetree Linden	Tiliaceae
Tilia platyphyllos	Bigleaf Linden	Tiliaceae
Tilia tomentosa	Silver Linden	Tiliaceae
Tsuga canadensis	Canadian Hemlock, Eastern Hemlock	Pinaceae
Tsuga caroliniana	Carolina Hemlock	Pinaceae
Ulmus americana	American Elm	Ulmaceae
Ulmus glabra	Scotch Elm	Ulmaceae
Ulmus parvifolia	Chinese Elm, Lacebark Elm	Ulmaceae
Ulmus pumila	Siberian Elm	Ulmaceae
Ulmus rubra	Slippery Elm	Ulmaceae
Vaccinium angustifolium	Lowbush Blueberry	Ericaceae
Vaccinium corymbosum	Highbush Blueberry	Ericaceae
Viburnum x burkwoodii	Burkwood Viburnum	Caprifoliaceae
Viburnum x carlcephalum	Fragrant Viburnum	Caprifoliaceae
Viburnum carlesii	Koreanspice Viburnum	Caprifoliaceae
Viburnum dentatum	Arrowwood Viburnum	Caprifoliaceae
Viburnum dilatatum	Linden Viburnum	Caprifoliaceae
Viburnum farreri	Fragrant Viburnum	Caprifoliaceae
Viburnum x juddii	Judd Viburnum	Caprifoliaceae
Viburnum lantana	Wayfaringtree Viburnum	Caprifoliaceae
Viburnum lentago	Nannyberry Viburnum, Sheepberry	Caprifoliaceae
Viburnum macrocephalum	Chinese Snowball Viburnum	Caprifoliaceae
Viburnum opulus	European Cranberrybush Viburnum	Caprifoliaceae
Viburnum plicatum tomentosum	Doublefile Viburnum	Caprifoliaceae
Viburnum prunifolium	Blackhaw Viburnum	Caprifoliaceae
Viburnum x rhytidophylloides	Lantanaphyllum Viburnum	Caprifoliaceae
Viburnum rhytidophyllum	Leatherleaf Viburnum	Caprifoliaceae
Viburnum rufidulum	Southern Blackhaw	Caprifoliaceae
Viburnum setigerum	Tea Viburnum	Caprifoliaceae
Viburnum sieboldii	Siebold Viburnum	Caprifoliaceae
Viburnum trilobum	American Cranberrybush Viburnum	Caprifoliaceae
Vinca minor	Common Periwinkle, Myrtle	Apocynaceae
Weigela florida	Old-fashioned Weigela	Caprifoliaceae
Wisteria floribunda	Japanese Wisteria	Leguminosae
Wisteria sinensis	Chinese Wisteria	Leguminosae
Zelkova serrata	Japanese Zelkova	Ulmaceae

Adapted from Dirr, Michael A. *Manual of Woody Landscape Plants, Their Identification, Ornamental Characteristics, Culture, Propagation and Uses*. Stipes Publishing Co., 10-12 Chester St., Champaign, IL 61820. 1980

SELECTED COMMON PLANTS OF NORTH AMERICA

LISTED ALPHABETICALLY BY *COMMON NAME*

Abelia, Glossy	Abelia x grandiflora
Akebia, Fiveleaf	Akebia quinata
Albizia	Albizia julibrissin
Alder	
Black	Alnus glutinosa *and* Ilex verticillata
Common	Alnus glutinosa
European	Alnus glutinosa
Allspice, Carolina	Calycanthus floridus
Almond, Dwarf Flowering	Prunus glandulosa
Althea, Shrub	Hibiscus syriacus
Ampelopsis, Porcelain	Ampelopsis brevipedunculata
Andromeda	Pieris japonica
Aralia, Fiveleaf	Acanthopanax sieboldianus
Arborvitae	
Eastern	Thuja occidentalis
Oriental	Thuja orientalis
Ash	
Blue	Fraxinus quadrangulata
European	Fraxinus excelsior
Green	Fraxinus pennsylvanica
Pumpkin	Fraxinus tomentosa
Red	Fraxinus pennsylvanica
White	Fraxinus americana
Aspen, Quaking	Populus tremuloides
Azalea	Rhododendron spp.
Baldcypress	Taxodium distichum
Barberry	
Chenault	Berberis x chenaultii
Japanese	Berberis thunbergii
Korean	Berberis koreana
Mentor	Berberis x mentorensis
Wintergreen	Berberis julianae
Bayberry, Northern	Myrica pensylvanica
Bearberry	Arctostaphylos uva-ursi
Beautybush	Kolkwitzia amabilis
Beech	
American	Fagus grandifolia
European	Fagus sylvatica
Birch	
Asian White	Betula platyphylla
Canoe	Betula papyrifera
European White	Betula pendula
Gray	Betula populifolia
Monarch	Betula maximowicziana
Paper	Betula papyrifera
Poplar	Betula populifolia
River	Betula nigra
Sweet	Betula lenta
White	Betula papyrifera
Bittersweet, American	Celastrus scandens
Black Gum	Nyssa sylvatica
Blackhaw, Southern	Viburnum rufidulum
Bladdernut, American	Staphylea trifolia
Blue Beech	Carpinus caroliniana
Blueberry	
Highbush	Vaccinium corymbosum
Lowbush	Vaccinium angustifolium
Box	
Common	Buxus sempervirens
Littleleaf	Buxus microphylla
Boxelder	Acer negundo
Boxwood	Buxus microphylla *and* Buxus sempervirens
Buckeye	
Bottlebrush	Aesculus parviflora
Fetid	Aesculus glabra
Ohio	Aesculus glabra
Red	Aesculus pavia
Yellow	Aesculus octandra
Buckthorn	
Common	Rhamnus cathartica
Glossy	Rhamnus frangula
Butternut	Juglans cinerea
Candytuft	Iberis sempervirens
Castor-aralia	Kalopanax pictus
Catalpa	
Common	Catalpa bignonioides
Hardy	Catalpa speciosa
Northern	Catalpa speciosa
Southern	Catalpa bignonioides
Western	Catalpa speciosa
Cedar	
Atlas	Cedrus atlantica
Deodar	Cedrus deodara
Cedar of Lebanon	Cedrus libani
Cherry	
Black	Prunus serotina
Higan	Prunus subhirtella
Manchu	Prunus tomentosa
Nanking	Prunus tomentosa
Oriental	Prunus serrulata
Chestnut	
American	Castanea dentata
Chinese	Castanea mollissima
Chinafir, Common	Cunninghamia lanceolata
Chokeberry	
Black	Aronia melanocarpa
Red	Aronia arbutifolia
Chokecherry, Common	Prunus virginiana
Cinquefoil, Bush	Potentilla fruticosa
Clematis, Jackman	Clematis x jackmanii
Clethra, Summersweet	Clethra alnifolia
Coffeetree, Kentucky	Gymnocladus dioicus
Coralberry	Ilex verticillata
Chenault	Symphoricarpos x chenaultii
Indiancurrant	Symphoricarpos orbiculatus
Corktree, Amur	Phellodendron amurense
Cotoneaster	
Bearberry	Cotoneaster dammeri
Cranberry	Cotoneaster apiculata
Hedge	Cotoneaster lucida
Many-flowered	Cotoneaster multiflora
Rock	Cotoneaster horizontalis
Spreading	Cotoneaster divaricata
Willowleaf	Cotoneaster salicifolia
Cottonwood, Eastern	Populus deltoides
Crabapple, Flowering	Malus spp.
Creeper	
Japanese - see *Japanese Creeper*	
Virginia - see *Virginia Creeper*	
Cryptomeria, Japanese	Cryptomeria japonica
Currant	
Alpine	Ribes alpinum
Clove	Ribes odoratum
Deutzia	
Fuzzy	Deutzia scabra
Slender	Deutzia gracilis
Devil's-walkingstick	Aralia spinosa
Dogwood	
Bloodtwig	Cornus sanguinea
Corneliancherry	Cornus mas
Flowering	Cornus florida
Gray	Cornus racemosa
Kousa	Cornus kousa
Pagoda	Cornus alternifolia
Red Osier	Cornus stolonifera
Silky	Cornus amomum
Tatarian	Cornus alba
Douglasfir	Pseudotsuga menziesii
Elaeagnus, Autumn	Elaeagnus umbellata
Elder, American	Sambucus canadensis
Elm	
American	Ulmus americana
Chinese	Ulmus parvifolia
Lacebark	Ulmus parvifolia
Scotch	Ulmus glabra
Siberian	Ulmus pumila
Slippery	Ulmus rubra
Enkianthus, Redvein	Enkianthus campanulatus
Euonymus	
Spreading	Euonymus kiautschovicus
Winged	Euonymus alatus
Winterberry	Euonymus bungeanus
Wintercreeper	Euonymus fortunei
Falsecypress	
Hinoki	Chamaecyparis obtusa
Japanese	Chamaecyparis pisifera
Lawson	Chamaecyparis lawsoniana
Nootka	Chamaecyparis nootkatensis
Fetterbush	Leucothoe fontanesiana
Filbert	
American	Corylus americana
European	Corylus avellana

Filbert *(cont.)*	
Purple Giant	Corylus maxima purpurea
Turkish	Corylus colurna
Fir	
Balsam	Abies balsamea
Fraser	Abies fraseri
Noble	Abies procera
White	Abies concolor
Firethorn, Scarlet	Pyracantha coccinea
Flowering Quince	
Common	Chaenomeles speciosa
Japanese	Chaenomeles japonica
Forsythia	
Border	Forsythia x intermedia
Greenstem	Forsythia viridissima
Weeping	Forsythia suspensa
Fothergilla	
Dwarf	Fothergilla gardenii
Large	Fothergilla major
Franklin Tree	Franklinia alatamaha
Franklinia	Franklinia alatamaha
Fringetree, White	Chionanthus virginicus
Ginkgo	Ginkgo biloba
Goldenchain Tree	Laburnum x watereri
Golden-larch	Pseudolarix kaempferi
Goldenraintree, Panicled - see *Panicled Goldenraintree*	
Grapeholly, Oregon - see *Oregon Grapeholly*	
Gum	
Black - see *Black Gum*	
Sour - see *Sour Gum*	
Hackberry	
Common	Celtis occidentalis
Sugar	Celtis laevigata
Hawthorn	
Cockspur	Crataegus crusgalli
Downy	Crataegus mollis
English	Crataegus oxyacantha
Glossy	Crataegus nitida
Lavalle	Crataegus x lavallei
Washington	Crataegus phaenopyrum
Hazel	Corylus colurna
Hedge-apple	Maclura pomifera
Hemlock	
Canadian	Tsuga canadensis
Carolina	Tsuga caroliniana
Eastern	Tsuga canadensis
Hercules-club	Aralia spinosa
Hickory	
Bitternut	Carya cordiformis
Shagbark	Carya ovata
Holly	
American	Ilex opaca
Blue	Ilex x meserveae
Chinese	Ilex cornuta
Foster's	Ilex x fosteri
Japanese	Ilex crenata
Longstalk	Ilex pedunculosa
Meserve	Ilex x meserveae
Michigan	Ilex verticillata
Honeylocust, Thornless	Gleditsia triacanthos var. inermis
Honeysuckle	
Amur	Lonicera maackii
Japanese	Lonicera japonica
Tatarian	Lonicera tatarica
Trumpet	Lonicera sempervirens
Winter	Lonicera fragrantissima
Hophornbeam, American	Ostrya virginiana
Hornbeam	
American	Carpinus caroliniana
European	Carpinus betulus
Horsechestnut	
Common	Aesculus hippocastanum
Red	Aesculus carnea
Hydrangea	
Climbing	Hydrangea anomala subsp. petiolaris
Oakleaf	Hydrangea quercifolia
Panicle	Hydrangea paniculata
Smooth	Hydrangea arborescens
Indian Bear	Catalpa bignonioides
Inkberry	Ilex glabra
Ironwood	Carpinus caroliniana *and* Ostrya virginiana
Ivy, English	Hedera helix
Japanese Creeper	Parthenocissus tricuspidata

Jetbead, Black	Rhodotypos scandens
Juniper	
Chinese	Juniperus chinensis
Common	Juniperus communis
Creeping	Juniperus horizontalis
Japanese Garden	Juniperus procumbens
Rocky Mountain	Juniperus scopulorum
Savin	Juniperus sabina
Shore	Juniperus conferta
Singleseed	Juniperus squamata
Kalmia, Moutain Laurel	Kalmia latifolia
Katsuratree	Cercidiphyllum japonicum
Kerria, Japanese	Kerria japonica
Laburnum, Waterer	Laburnum x watereri
Larch	
European	Larix decidua
Japanese	Larix kaempferi
Laurel	Magnolia virginiana *or* see *Mountain Laurel Kalmia*
Leucothoe, Drooping	Leucothoe fontanesiana
Lilac	
Chinese	Syringa x chinensis
Common	Syringa vulgaris
Japanese Tree	Syringa amurensis japonica *or* S. reticulata
Late	Syringa villosa
Meyer	Syringa meyeri
Lily-of-the-valley Tree	Oxydendrum arboreum
Lilyturf	Liriope spicata
Linden	
American	Tilia americana
Beetree	Tilia heterophylla
Bigleaf	Tilia platyphyllos
Crimean	Tilia x euchlora
European	Tilia x europaea
Littleleaf	Tilia cordata
Silver	Tilia tomentosa
Locust	
Black	Robinia pseudoacacia
Common	Robinia pseudoacacia
Magnolia	
Bigleaf	Magnolia macrophylla
Cucumbertree	Magnolia acuminata
Kobus	Magnolia kobus
Lily	Magnolia liliflora
Saucer	Magnolia x soulangiana
Southern	Magnolia grandiflora
Star	Magnolia stellata
Swamp	Magnolia virginiana
Sweetbay	Magnolia virginiana
Tulip - see *Tulip Magnolia*	
Umbrella	Magnolia tripetala
Maidenhair Tree	Ginkgo biloba
Maple	
Amur	Acer ginnala
Fullmoon	Acer japonicum
Hard	Acer saccharum
Hedge	Acer campestre
Japanese	Acer palmatum
Norway	Acer platanoides
Paperbark	Acer griseum
Planetree	Acer pseudoplatanus
Red	Acer rubrum
Rock	Acer saccharum
Silver	Acer saccharinum
Striped	Acer pensylvanicum
Sugar	Acer saccharum
Sycamore	Acer pseudoplatanus
Tatarian	Acer tataricum
Trident	Acer buergerianum
Mimosa	Albizia julibrissin
Mockorange, Sweet	Philadelphus coronarius
Moosewood	Acer pensylvanicum
Mountain Laurel Kalmia	Kalmia latifolia
Mountainash	
American	Sorbus americana
European	Sorbus aucuparia
Korean	Sorbus alnifolia
Mulberry	
Common	Morus alba
Red	Morus rubra
White	Morus alba
Myrtle	Vinca minor
Ninebark	
Common	Physocarpus opulifolius

Ninebark *(cont.)*	
Eastern	Physocarpus opulifolius
Oak	
Black	Quercus velutina
Bur	Quercus macrocarpa
Chestnut	Quercus prinus
Chinkapin	Quercus muehlenbergii
English	Quercus robur
Laurel	Quercus imbricaria
Mossycup	Quercus macrocarpa
Oriental	Quercus variabilis
Pin	Quercus palustris
Red	Quercus rubra
Sawtooth	Quercus acutissima
Scarlet	Quercus coccinea
Shingle	Quercus imbricaria
Shumard	Quercus shumardi
Swamp	Quercus palustris
Swamp White	Quercus bicolor
White	Quercus alba
Willow	Quercus phellos
Yellow Chestnut	Quercus muehlenbergii
Oregon Grapeholly	Mahonia aquifolium
Osage-orange	Maclura pomifera
Pachysandra, Japanese	Pachysandra terminalis
Pagodatree, Japanese	Sophora japonica
Panicled Goldenraintree	Koelreuteria paniculata
Pawpaw, Common	Asimina triloba
Paxistima, Canby	Paxistima canbyi
Peach, Common	Prunus persica
Pear	
Callery	Pyrus calleryana
Common	Pyrus communis
Willowleaf	Pyrus salicifolia
Peashrub, Siberian	Caragana arborescens
Pecan	Carya illinoinensis
Pepperidge	Nyssa sylvatica
Periwinkle, Common	Vinca minor
Persimmon, Common	Diospyros virginiana
Photinia, Oriental	Photinia villosa
Pieris	
Japanese	Pieris japonica
Mountain	Pieris floribunda
Pine	
Austrian	Pinus nigra
Bristlecone	Pinus aristata
Colorado	Pinus edulus
Dwarf Swiss Mountain	Pinus mugo mugo
Eastern White	Pinus strobus
Himalayan	Pinus wallichiana
Jack	Pinus banksiana
Japanese Black	Pinus thunbergiana
Japanese Red	Pinus densiflora
Japanese White	Pinus parviflora
Jersey	Pinus virginiana
Lacebark	Pinus bungeana
Limber	Pinus flexilis
Pitch	Pinus rigida
Ponderosa	Pinus ponderosa
Poverty	Pinus virginiana
Red	Pinus resinosa
Scotch	Pinus sylvestris
Scrub	Pinus virginiana
Spruce	Pinus virginiana
Swiss Mountain	Pinus mugo
Swiss Stone	Pinus cembra
Virginia	Pinus virginiana
Planetree	
American	Platanus occidentalis
London	Platanus acerifolia
Plum	
Cherry	Prunus cerasifera
Flowering	Prunus triloba
Pondcypress	Taxodium ascendens
Poplar	
Silver-leaved	Populus alba
Tulip - see *Tulip Poplar*	
White	Populus alba
Yellow - see *Yellow Poplar*	
Possumhaw	Ilex decidua
Privet	
Border	Ligustrum obtusifolium
European	Ligustrum vulgare
Golden	Ligustrum x vicaryi
Quaking Aspen - see *Aspen, Quaking*	

Redbud, Eastern	Cercis canadensis
Redcedar, Eastern	Juniperus virginiana
Redwood, Dawn	Metasequoia glyptostroboides
Rhododendron	Rhododendron spp.
Rockspray	Cotoneaster horizontalis
Rose-of-Sharon	Hibiscus syriacus
Rubber Tree, Hardy	Eucommia ulmoides
Russian Olive	Elaeagnus angustifolia
St. Johnswort, Shrubby	Hypericum prolificum
Sassafras, Common	Sassafras albidum
Sawara	Chamaecyparis pisifera
Scholar-tree	Sophora japonica
Serviceberry	
Allegheny	Amelanchier laevis
Running	Amelanchier stolonifera
Sheepberry	Viburnum lentago
Silk-tree	Albizia julibrissin
Silverbell, Carolina	Halesia carolina
Smokebush	Cotinus coggygria
Smoketree, Common	Cotinus coggygria
Snowbell, Japanese	Styrax japonicum
Snowberry, Common	Symphoricarpos albus
Snow-wreath	Neviusia alabamensis
Sorrel Tree	Oxydendrum arboreum
Sour Gum	Nyssa sylvatica
Sourwood	Oxydendrum arboreum
Spicebush	Lindera benzoin
Spirea	
Bridalwreath	Spiraea prunifolia
Bumald	Spiraea bumalda
Garland	Spiraea arguta
Thunberg	Spiraea thunbergii
Vanhoutte	Spiraea x vanhouttei
Spruce	
Blue	Picea pungens glauca
Colorado	Picea pungens
Engelmann	Picea engelmannii
Norway	Picea abies
Oriental	Picea orientalis
Serbian	Picea omorika
White	Picea glauca
Spurge	Pachysandra terminalis
Stephanandra, Cutleaf	Stephanandra incisa
Stewartia	
Japanese	Stewartia pseudo-camellia
Mountain	Stewartia ovata
Strawberry-shrub	Calycanthus floridus
Sumac	
Chinese	Rhus chinensis
Flameleaf	Rhus copallina
Fragrant	Rhus aromatica
Smooth	Rhus glabra
Staghorn	Rhus typhina
Sweetgum	Liquidambar styraciflua
Sweetshrub, Common	Calycanthus floridus
Sycamore	Platanus occidentalis
Tree-of-heaven	Ailanthus altissima
Trumpetcreeper, Common	Campsis radicans
Tulip Magnolia	Liriodendron tulipifera
Tulip Poplar	Liriodendron tulipifera
Tuliptree	Liriodendron tulipifera
Tupelo, Black	Nyssa sylvatica
Umbrella-pine	Sciadopitys verticillata
Varnish Tree	Koelreuteria paniculata
Viburnum	
American Cranberrybush	Viburnum trilobum
Arrowwood	Viburnum dentatum
Blackhaw	Viburnum prunifolium
Burkwood	Viburnum x burkwoodii
Chinese Snowball	Viburnum macrocephalum
Doublefile	Viburnum plicatum tomentosum
European Cranberrybush	Viburnum opulus
Fragrant	Viburnum x carlcephalum *and* Viburnum farreri
Judd	Viburnum x juddii
Koreanspice	Viburnum carlesii
Lantanaphyllum	Viburnum rhytidophylloides
Leatherleaf	Viburnum rhytidophyllum
Linden	Viburnum dilatatum
Nannyberry	Viburnum lentago
Siebold	Viburnum sieboldii
Tea	Viburnum setigerum
Wayfaringtree	Viburnum lantana
Virgilia	Cladrastis lutea
Virginia Creeper	Parthenocissus quinquefolia

Walnut, Black	Juglans nigra
Weigela, Old-fashioned	Weigela florida
Willow	
Babylon Weeping	Salix babylonica
Corkscrew	Salix matsudana 'Tortuosa'
Goat	Salix caprea
Pussy	Salix discolor
White	Salix alba
Winterberry, Common	Ilex verticillata
Winterhazel, Fragrant	Corylopsis glabrescens
Wisteria	
Chinese	Wisteria floribunda
Japanese	Wisteria sinensis
Witchhazel	
Chinese	Hamamelis mollis
Common	Hamamelis virginiana
Vernal	Hamamelis vernalis
Woodbine	Parthenocissus quinquefolia
Yellow Poplar	Liriodendron tulipifera
Yellowwood, American	Cladrastis lutea
Yew	
Anglo-Japanese	Taxus x media
Canadian	Taxus canadensis
English	Taxus baccata
Japanese	Taxus cuspidata
Zelkova, Japanese	Zelkova serrata

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GLOSSARY

abscission - leaf or fruit drop

abscission zone - area at the base of the petiole where cellular breakdown leads to leaf or fruit drop

absorption - taking up; sucking up

acorn - thick-walled globular nut with a cup-like base; the fruit of oak

acuminate - having an apex the sides of which are gradually concave and taper to a point

acute - having an apex the sides of which are straight and taper to a point

adpressed - in close, tight proximity

aeration - provision of ample oxygen

aerial lift (bucket truck) - truck with booms and bucket used to put a worker in proximity to the tree work to be done

aerial rescue - method used to bring an injured person down from a tree

aesthetic - relating to artistic, pleasing characteristics

aggregate - close cluster

air terminal - the portion of a lightning protection cable that extends beyond the top of the tree

alternate leaved - having leaves situated one at each node and alternating in position on the stem

angiosperm - plant with seeds borne in an ovary

annual ring - ring of xylem in wood that indicates a year of growth

anther - portion of the stamen where pollen is borne

anthocyanin - red or purplish pigment

apex (plural, **apices**) - the tip or point of a leaf or stem

arboriculture - the study of trees and other plants

arborist - person devoted to the care, maintenance and study of trees

aromatic - fragrantly scented

artificial respiration - forcing air into the lungs of a person who has stopped breathing

auxin - plant hormone

backfill - the soil and amendments put back into a hole following planting or transplanting

bacterium (plural, **bacteria**) - one of a group of microscopic plants, some of which cause disease

balled and burlapped - having the root system and soil wrapped in burlap for moving and planting

bareroot - having the root system exposed without soil or protective wrap

bark - stem tissues from the cambium outward

bark tracing - cutting away torn or injured bark to leave a smooth edge

bell cap - device used to cover the exposed portion of an upright tile

berry - fleshy, multi-seeded fruit

biodegradable - capable of decaying and being absorbed by the environment

bipinnate - doubly pinnate

blade - the expanded part of a leaf

blight - disease that kills young growing tissue

body thrust - method of ascending a tree using a rope

bonsai - the art of culturing dwarfed plants grown in pots

boom - long, movable arm(s) on which the bucket is mounted in a bucket truck

bowline - looped knot used to attach clips (snaps) to a rope, and to lower limbs from a tree

bracing - installation of a rod through a weak portion of a tree for added support

bract - modified leaf from which an inflorescence arises

branch bark ridge - area of a crotch where the bark is rippled due to the joining of the two branches

branch collar - swollen area where one branch meets another

broadleaf evergreen - non-coniferous plant that maintains its foliage throughout the year

brush chipper - piece of equipment used to grind branches into wood chips

bucket truck (aerial lift) - truck equipped with apparatus for placing worker in proximity to high limbs

bucking - cutting a tree into logs of usable length

bud - undeveloped swelling composed mostly of meristematic tissue

bud scale - modified, protective leaf of a bud

bull rope - large rope, usually ¾ inch in diameter, used to lower large limbs from a tree

bumper spikes - metal spikes on larger chain saws that grip the log as the saw is drawn in

butt end - end of a branch where the cut was made

buttress roots - roots at the base of the trunk; trunk flare

CPR - cardiopulmonary resuscitation; procedure used to force air into the lungs and to force blood circulation in a person who has suffered cardiac arrest

cable wrap - device used in cabling trees; replaces the U-bolt and splice

cabling - method of installing hardware (cables and lag hooks) in a tree to help correct weak crotches

caliper - diameter of a tree

calyx - collective term for the sepals

cambium - layer(s) of cells that gives rise to new xylem and phloem

candle growth - new growth on a conifer

canker - localized diseased area on stems and wood

canopy - the entire branch scaffolding and foliage of a tree

capsule - dry fruit produced from a compound pistil

carbohydrate - compound combining forms of carbon and water

carotenoid - a yellow, orange or red pigment

catkin - spike-like inflorescence

cell - smallest unit of an organism that is capable of self-reproduction

chaps - heavy material worn over the pants to protect the legs when using a chain saw

chlorophyll - green pigment of plants, found in chloroplasts

chlorosis - whitish or yellowish discoloration; lack of chlorophyll

class - the taxonomic division under the phylum

climber's saddle - safety harness worn by tree climbers

climbing rope - rope used by tree climbers for safety and maneuverability (usually ½ inch in diameter and 120 feet long)

climbing spurs (climbing spikes) - long, pointed spurs that are strapped to the inside of the legs to aid in climbing trees

clone - group of plants derived vegetatively from a parent plant and genetically identical to the parent plant

clove hitch - knot used to secure an object to a rope

"come-along" - device used to draw two things closer together

complete fertilizer - fertilizer that contains nitrogen, phosphorus and potassium

compound leaf - a leaf with two or more leaflets

conductive (vascular) tissue - parts of the plant which carry water or nutrients

conductor - any object that can carry an electric current

cone - the fruit of a conifer with woody or leathery scales

conifer - cone-bearing tree

cordate - heart-shaped

cork cambium - the cambium from which cork develops

cork cells - external stem tissue that is impermeable to water and gases

corolla - collective term for the petals

cortex - the cells between the epidermis and conducting tissues

coupling - device for joining two things together such as wire, cable or pipes

crenate - having rounded marginal teeth

cross section - section cut perpendicular to the axis of longitudinal growth

crown - the upper mass of a tree

cultivar - a cultivated variety

cuticle - waxy layer outside the epidermis

D-rings - large, D-shaped metal rings attached to the safety harness and used to attach ropes and tools

damping-off - disease of seedlings characterized by dying stem and root tissues

deadwooding - pruning to remove dead limbs from trees

deciduous - trees and shrubs that lose their leaves in the fall

deficiency - lack or insufficient quantity of a required nutrient

defoliation - loss of leaves from a plant

deltoid - triangular

dentate - having marginal teeth which are perpendicular to the margin

desiccation - drying up

dichotomous venation - pattern of leaf venation in which vascular bundles fork in pairs

dieback - condition in which the ends of branches are dying

dielectric integrity - an unimpaired condition of non-conductivity

differentiation - developmental specialization of plant tissues

dioecious - plant with unisexual flowers with each sex confined to separate plants

dissemination - spreading or dispersal

dormant - state of reduced physiological activity

double-crotching - a method of working in a tree, which involves tying the climbing line into two separate crotches

double-serrate - toothed margin of leaf with smaller teeth within

drainage tile - large clay or plastic pipes used to collect and reroute subsurface water

drift - spray droplets carried by air movement to non-target areas

drip line - the full extension of a tree's canopy over the ground below

drop crotch pruning - cutting each limb back to a desirable lateral branch

drop line - a rope used to lower limbs from a tree

drupe - fleshy fruit with a stony covering over the seed

dry well - large well constructed around a tree to maintain aeration in the root zone

egg - female gamete

electrocution - fatality caused by electric shock

elliptical - oval; shaped like an ellipse

energized - carrying an electric charge

entire (leaf) - having a margin without teeth

entomology - the study of insects

epidermis - outer tissue of leaves, stems, roots, flowers, fruits and seeds

epinasty - distortion of growth

espalier - a plant trained to grow against a wall or other support

evergreen - having green foliage throughout the year

exfoliating - peeling off in shreds or layers

exudation - oozing out

false crotch - device used to lower limbs from a tree when there is no convenient crotch

family - the taxonomic division under *order*

feeder roots - small, fibrous roots which are active in the uptake of water and minerals

felling - the act of cutting down a tree

fertilization - union of sperm with egg — the start of a new individual

fertilizer - a substance added to a plant or its surrounding soil to supplement the supply of required nutrients

fertilizer analysis - the percentage of nitrogen, phosphorus and potassium in a fertilizer

figure 8 knot - knot used to prevent slipping of the end of the rope through the knot

filament - stalk of the stamen

filamentous - thread-like

flower bud - a bud that will develop into a flower (reproductive tissues)

foliage - the leaves of a plant

follicle - dry fruit which opens along one side, produced from a single carpel

footlock - method of climbing a rope by wrapping the rope around one's feet

fungus (plural, **fungi**) - non-photosynthetic plant, in certain cases causing disease

gall - swelling in plant tissues frequently caused by insects

gamete - sex cell

genus - a group of species having similar fundamental traits

girdling - inhibition of the flow of water and nutrients by "choking" the vascular elements

glabrous - smooth, not hairy

grafting - method of propagation by which parts (twigs) of separate plants are joined

grounded - electrically connected to the earth

guard cells - pair of cells which control the opening and closing of the stoma

guide bar - bar of chain saw around which the cutting chain rotates

gummosis - exudation of sap often in response to disease or insect damage

guying - securing a tree with ropes or cables fastened to stakes in the ground

gymnosperm - plant with seeds borne exposed

half hitch - simple wrap of a rope used to secure the line temporarily

hand pruners - small pruning tool for pruning limbs less than ½ inch in diameter

heading back - cutting each limb back to a lateral branch when pruning

heartwood - inner, darker wood that is not active in water transport

hedge shears - scissor-like tool for formal pruning of shrubs and hedges

honeydew - substance secreted by certain insects when feeding upon plants

hydraulic - operated by forced fluids

hydraulic tools - tools (pole pruners, saws) powered by hydraulics; mostly used from aerial lifts

IPM - Integrated Pest Management - a combined approach to controlling plant pests utilizing alternative methods

imperfect flower - a flower with only stamens or pistils, not both

implant - device or pellet which can be inserted into a tree to treat disorders

increment borer - device used to take core samples from trees for the purpose of determining age or detecting problems

inflorescence - flower or group of flowers; disposition of flowers on the plant

injection - forcing of chemical fluids into the vascular elements of a tree for the purpose of treating disorders

inoculum - pathogen or disease-causing substance; material which introduces disease

insulation - non-conducting material placed over a conductor

internode - the region of the stem between two successive nodes

intervenal tissue - leaf tissue between the veins or vascular bundles

kickback - sudden backward or upward thrust of a chain saw

kingdom - in taxonomy, the primary division into which all organisms are classified: either plant or animal

lag hook - device used in cabling trees; it has threads at one end for anchoring in the tree and a hook at the other end for attaching the cable

larva - immature life stage of an insect

lateral - side or offshoot branch

lateral bud - vegetative bud on the side of a stem

leach - wash through and out of the topsoil

leader - the primary terminal shoot or trunk of a tree

leaf blotch - irregularly shaped areas of disease on plant foliage

leaf scar - scar left on the twig after the leaf falls

leaflet - separate part of a compound leaf blade

leafspot - patches of disease or other damage on plant foliage

legume - dry fruit opening on both sides and produced from a single carpel

leguminous - relating to legume plants

lenticel - opening in the bark that permits the exchange of gases

limbing - removing the side limbs of a tree

line clearance - removal of trees or limbs that may interfere with utility lines

lobed - having a shape with projecting segments or lobes

lopping shears (loppers) - long-handled pruning tools for limbs less than 1½ inches in diameter

malodorous (odoriferous) - having an unpleasant odor

margin - the outer edge of the leaf blade

mechanical tree spade - machinery used to dig large trees for transplanting

meristem - undifferentiated tissue where active cell division takes place

micronutrients - essential elements required by plants in relatively small quantities

midrib - the central vascular bundle of a leaf

mildew - fungus disease superficial to or penetrating leaf tissues

monkey's fist - a series of wraps in a rope to facilitate throwing the rope through a crotch

monoecious - plant with unisexual flowers and both sexes on the same plant

morphology - study of the form or shape of an object

mulch - material used as a covering over soil to maintain even soil temperature, reduce evaporation, reduce erosion, reduce weeds, enrich the soil, or unify the landscape

mycoplasma - microscopic, parasitic organism some forms of which cause disease

necrosis - localized death of tissue in a living organism

needle - slender conifer leaf

nematode - microscopic eelworm that often feeds on plant tissues and may cause disease

node - slightly enlarged portion of the stem where leaves and buds arise

nomenclature - a system of naming

notch - wedge-shaped cut in a tree to help control the felling direction

nutlet - a small nut

oblique - lop-sided, with one side larger than the other

obtuse - rounded, approaching semi-circular

oedema - watery swelling in plant tissue due to abnormal water conditions

opposite leaved - leaves situated two at each node across from each other on the stem

order - taxonomic division of *class*

outriggers - projecting structures on boom trucks and other large vehicles; used for stabilization

ovary - lower part of carpel which becomes the fruit

ovate (ovoid) - egg-shaped

ovule - structure which encloses the egg

pH - a measure of acidity or alkalinity

PTO - power take-off; a supplementary mechanism enabling the engine power to be used to operate non-automotive apparatus

palisade layer - elongated leaf cells found just beneath the upper epidermis

palmate - radiating in a fan-like manner

panicle - type of influorescence with the primary axis bearing branches of flowers

parallel venation - pattern of leaf venation in which the veins extend through the leaf side by side

parasite - organism living in or on another organism from which it derives nourishment

pathogen - causal agent of disease

perfect flower - a flower with both pistils and stamens

petal - the flower "leaf"; usually colorful

petiole - stalk of a leaf

petiolule - stalk of a leaflet

phase-to-phase wires - type of electric utility lines that carry high voltage

phelloderm - layer of cells in the stem of some plants; formed from the inner cells of the cork cambium

pheromone - chemical substance produced by insects; serves as a stimulus to other insects of the same species

phloem - food-conducting tissues

photosynthesis - the process in green plants by which light energy is used to form organic compounds from water and carbon dioxide

phylum - the primary taxonomic division within *kingdom*

pigment - a substance that appears colored due to the absorbance of certain light wave lengths

pinnate - compound leaf with leaflets along each side of a common axis

pistil - floral organ where the egg is produced; usually composed of ovary, style and stigma

pith - soft tissue in the center of the stem

plant anatomy - the study of the structure and composition of plants

plant hormone - compound produced by a plant that affects physiological processes such as growth

plant pathology - the study of plant diseases

plant physiology - the study of life functions of plants

pneumatic - operated by air pressure

pole pruner (pole clip) - long pole with pruner attached; used for pruning difficult-to-reach limbs

pole saw - long pole with pruning saw attached; used for cutting difficult-to-reach branches

pollen - fine dusty substance from which the sperm arise in seed plants

pollination - transfer of pollen to a receptive stigma or ovulate cone

polygamo-dioecious - having male and female flowers on separate plants, but having perfect flowers as well

pome - fleshy fruit produced from a compound ovary

pressure loss - drop in fluid pressure due to friction in hose or pipe

propagation - multiplication of plants by sexual or asexual reproduction

pruning - cutting away unwanted parts of a plant

pruning saw - saw used for pruning plants; often arched and frequently with teeth arranged for cutting on the pull stroke

pubescent - covered with short, soft hairs

radial section - longitudinal section cut to coincide with the radius of the stem (trunk)

ray - tissues that extend radially in the xylem and phloem of a tree

reflexed - bent abruptly backward

resinous - secreting a sticky substance

respiration - process by which sugars and other compounds are broken down

respirator - device worn over the mouth and nose for protecting the respiratory tract

rigging - the art of using ropes to lower limbs from a tree

root hairs - thin, hairlike projections of root tissue that increase water absorption

running bowline - bowline used as a slip knot

rust - disease caused by a certain group of fungi and characterized by reddish brown spotting

safety rope (safety line) - a short (approx. 6 feet) length of rope with snaps at each end, used to temporarily secure the climber in a tree

samara - dry fruit having a wing

sanitation - practice of removing dead or diseased plant parts to reduce the amount of inoculum and avoid further disease spread

sapwood - outer wood that actively transports water and nutrients

scabbard - sheath for pruning saw (hand saw)

scale - one of a group of insects that attach themselves to plant parts and suck the juices

scorch - browning and shriveling of leaves, especially at the margins

seed - the mature ovule

seedling - young, germinated plant

sepals - leaflike structures that enclose the other flower parts

serrate - sawtooth margin of leaf with the teeth pointed forward

sheet bend - knot used to tie together two ropes of unequal diameter

shinny - to move up a limb or pole by clinging to it alternately with arms and legs

simple leaf - a single, one-part leaf not composed of leaflets

sinus - the space between two lobes or segments

slow-release fertilizer - fertilizer formulated to release nitrogen gradually over a long period

smut - disease caused by a certain group of fungi and characterized by small, black, spore-filled pustules

snaps - metal clips on the climbing saddle, climbing rope or safety line

soil amendment - material added to soil to improve its physical or chemical properties

soil auger - device for removing cores of soil for inspection or testing

species - a group of organisms composed of similar individuals which can produce similar offspring

sperm - male gamete

spongy layer - leaf cells that contain a large number of chloroplasts and substantial intercellular space

sprayer calibration - calculation of the appropriate pressure setting for the sprayer pump, once the disk size, height of spray, hose diameter, and length of hose are known

sprocket - toothed wheel which engages the chain on a chain saw

square knot - a knot used to tie together two ropes of equal diameter

staking - supporting a newly planted tree with stakes

stamen - floral organ in which pollen is produced; usually composed of anther and filament

standard down conductor - length of copper cable used in lightning protection systems on trees

stigma - portion of the style to which pollen adheres

stippling - speckled or dotted areas

stoma (plural, **stomata**) - small pore between two guard cells on leaves and stems, through which gases are exchanged

stump remover (stump grinder) - machinery used to grind out tree stumps

stunting - reduction of growth

style - stalk of the pistil

stylet - portion of the sucking mouthparts of an insect

sucker (water shoot) - shoot arising from the roots

systemic - acting throughout the entire organism

tangential section - longitudinal section cut at right angles to the radius

tautline hitch - the "climber's knot" used by tree climbers to secure the climbing rope

taxonomy - the classification and naming of organisms

tendril - slender, coiling offshoot of the stem that aids in support

terminal bud - bud at the end of a stem

throwing ball - device consisting of a long string with a padded weight attached; used for placing a rope high in a tree

tied in - condition in which the climber's rope is secured in the tree with a tautline hitch

timber hitch - a knot used to secure a rope to a log

topiary - the art of training and pruning trees and shrubs into ornamental shapes

topping - cutting each limb back

transpiration - loss of water from the surface of leaves

transplant - move a plant to a new location

undulate - in leaves, having a wavy margin

valvate - meeting by the edges without overlapping

variety - subdivision of a species having a distinct difference, and breeding true to that difference

vascular discoloration - darkening of the vascular tissues of woody plants in response to disease

vascular tissue - tissue that conducts water or nutrients

vector - organism that transmits a pathogen

vegetative bud - bud that will develop into non-reproductive parts (leaves, branches)

venation - arrangement of veins

virus - microscopic causative agent of disease

water shoot - a secondary, upright shoot arising from the trunk, branches or roots of a plant

water-soaked - oily appearance symptomatic of bacterial disease

wheel blocks - devices used to block the tires of a vehicle to keep it from rolling

whorled - leaves arranged in a circle around a point on the stem

wilt - loss of turgidity and subsequent drooping of soft tissues

winged twigs - twigs with thin, dry, membranous appendages

witches' broom - plant disorder in which a large number of accessory shoots develop

wound dressing - compound applied to tree wounds or cuts

xylem - water-conducting tissue

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